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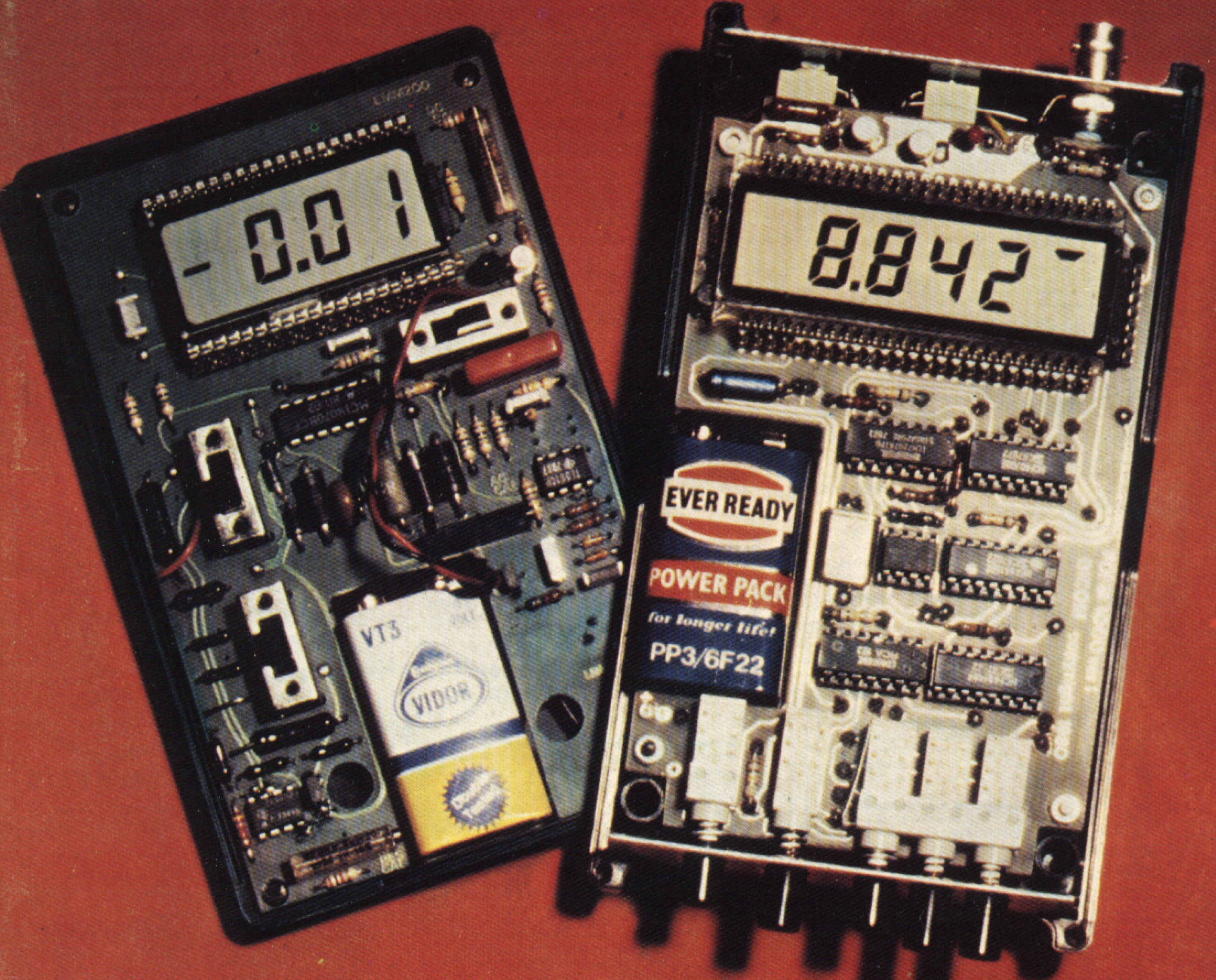

PE DMM *and the* PE DFM

Also...

CASIO WATCH OFFER

SINCLAIR ZX80 REVIEW

PRACTICAL
ELECTRONICS

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OUR AUGUST ISSUE WILL BE ON SALE SATURDAY, 26 JULY 1980
(for details of contents see page 41)

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PE **VOLUME 16 No. 7 JULY 1980**

IN PRAISE OF THE READER

THE great strength of PE has always been its readers. That may sound like an unusual statement but basically it's true. Just look carefully at any issue, and, with a little thought, you will realise what we mean.

Take last month for instance, out of five projects four were originally designed and built by readers for their own use, either at home or work. Add to that four pages of IUs, all contributed by readers, and three pages of *Microbus* much of which also came from readers; plus a controversial page of *Readout*. Not only do you buy and read the issues but you also write a good proportion of them!

But that is not the only strength we derive from you, in many cases we have your brand loyalty (for want of a better phrase), we know that many have been readers from issue one. You have changed with us from one or two transistor projects through to hobby computers, electronic pianos and high quality test gear. At one time many thought that the IC would never be used in any number by hobbyists, with your help that idea was quickly changed. Very often it has been demand from you that has made devices available through retailers. Devices that were built for industry have been ingeniously employed by the hobbyist and a second market has grown.

Some of your designs have been taken up by industry in various forms, and many companies have long recognised the wealth of information in our pages. Without you these ingenious ideas would be few and we would all be the poorer.

We appreciate your loyalty, your ingenuity, your comments and criticisms. Understandably, most of you only write to us when you have a grievance or a problem with a project, but thankfully your letters often contain that extra line which says "Why do you give so much space to musical projects?", or "How about an electronic boomerang?", or perhaps even "Great mag, keep it up!". They are all noted and give us the feedback we require to point PE in the right direction and hopefully keep you happy.

Keep the designs and comments coming, and bash us if you want—one kick won't change our shape, but your's may not be the only boot hitting that spot!

Lastly, thank you for your patience, our June issue was published a month late due to the NGA dispute with the printers (we really put our foot in it in the May editorial). We still expect to be able to bring you 12 issues this year but it will take some time before we are back to normal publishing dates.

FOOD FOR THOUGHT

It appears to us that although most readers receive good service, there is a small element of mistrust, misunderstanding and possibly dissatisfaction with some mail order suppliers; we would like your general views on buying components by post, including any ideas you may have. In turn we hope to be able to publish your views and those of the retailers; to show both sides the others' problems, and to make you aware of your legal rights and the protection our mail order scheme affords should things go wrong.

Mike Kenward

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Technical Queries

We are unable to offer any advice on the use or purchase of commercial equipment or the incorporation or modification of designs published in Practical Electronics.

All letters requiring a reply should be accompanied by a stamped, self addressed envelope and each letter should relate to **one published project only.**

Components are usually available from advertisers; where we anticipate supply difficulties a source will be suggested.

Back Numbers

Copies of most of our recent issues are available from: Post Sales Department (Practical Electronics), IPC Magazines Ltd., Lavington House, 25 Lavington Street, London SE1 0PF, at 75p each including Inland/Overseas p&p.

Binders

Binders for PE are available from the same address as back numbers at £4·10 each to UK or overseas addresses, including postage and packing, and VAT where appropriate. Orders should state the year and volume required.

Subscriptions

Copies of PE are available by post, inland or overseas, for £10·60 per 12 issues, from: Practical Electronics, Subscription Department, Oakfield House, Perrymount Road, Haywards Heath, West Sussex RH16 3DH. Cheques and postal orders should be made payable to IPC Magazines Limited.

Market Place

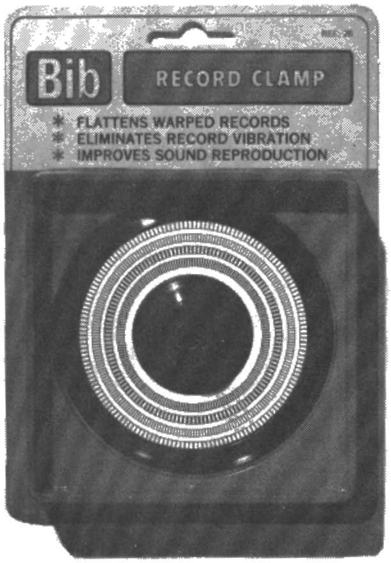
Items mentioned are usually available from electronic equipment and component retailers advertising in this magazine. However, where a full address is given, enquiries and orders should then be made direct to the firm concerned. All quoted prices are those at the time of going to press.

by David Shortland and Jasper Scott

CLAMPING DOWN

If you are a hi-fi accessory enthusiast, you will no doubt be unable to resist the latest offering from BIB—their Record Clamp.

Being yet another accessory that cashes in on poor quality pressings, the BIB Record Clamp is primarily intended to flatten warped records, thereby reducing vibration and improving sound quality. This it does by clamping the record firmly to the turntable, when it is locked to the centre spindle. A stroboscopic disc is also incorporated in the clamp, so that the playing speed may be checked. The RRP for the clamp is £2·48 including VAT, and it should be available from most hi-fi dealers and record retailers.

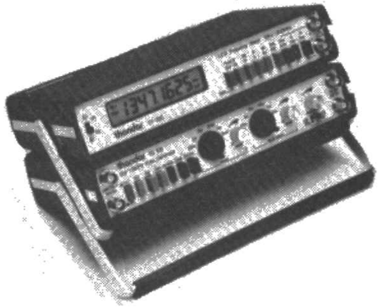

Bib
RECORD CLAMP
* FLATTENS WARPED RECORDS
* ELIMINATES RECORD VIBRATION
* IMPROVES SOUND REPRODUCTION

THANDAR

Sinclair Electronics have introduced two new products to their Thandar test equipment range.

The TF200 is a bench/portable frequency meter covering the range 10Hz to 200MHz with an 8 digit l.c.d. readout. An external prescaler unit will be available in the future to increase the upper frequency capability to 600MHz.

The instrument can be operated either from internal batteries or an external a.c. adaptor. Typical battery life is over 200 hours.



The TG105 is housed in the same case style as the TF200 and this general purpose pulse generator covers a range of 5Hz to 5MHz. The period and pulse width controls are independently adjustable whilst the output is continuously variable in two switched ranges to a maximum of 10V from a 50ohm source. A TTL output is also provided.

Operating modes include free-run, triggered, gated and one shot, with complement and square wave functions effective on both the 50ohm and TTL outputs. Jitter free pulse trains with duty cycles of 0% to 100% can be achieved with a special inhibit circuit to blank the output when the pulse width is set larger than the period.

The TG105 which is a mains operated instrument retails at £85 whilst the TF200 is £145. (ex VAT and p&p).

A. Marshall's (London) Ltd., Kingsgate House, Kingsgate Place, London NW6 (01-624 0805).

RHYTHM COMPUTER

As easy to use as a pocket calculator with a programmable versatility only limited by the imagination is the new DR55 Doctor Rhythm.

Measuring 211 × 116 × 53mm and weighing only 850g the unit is truly pocket size affording the musician a portable drummer which can provide the sounds of bass drum, hi-hat and rim shot.

Six 16-step rhythm patterns and two 12-step patterns are available supplemented by a variable level accent control. An A and B function switch allows inversion of the patterns. An optional footswitch is available for starting and stopping.

At £89·50 a worthwhile investment for the soloist requiring more than a metronome accompaniment. Further information from **Brodr Jorgensen (UK) Ltd, Great West Trading Estate, 983 Great West Road, Brentford, Middlesex.**

SOFTY

Two new products designed for direct connection to the SOFTY Intelligent EPROM Programmer Card have been announced by GP Industrial Electronics Ltd. The first product is a Conversion Card which enables SOFTY to program the 2508, 2758, (INTEL 2716) and 2532 single rail EPROMs.

Device type and 1K blocks are selectable by 4 way p.c.b. slide switches. The programming socket is a lever operated zero insertion force. Supplied built and tested, complete with a d.i.p. jumper for connection to SOFTY for £46·00 inclusive of VAT and post and packing.

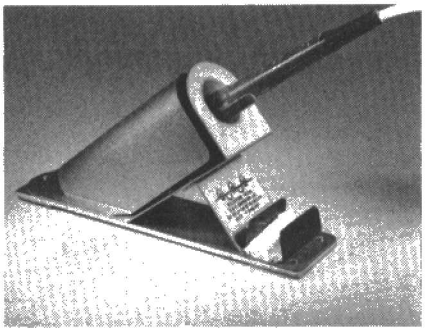
The second product is the SOFTY Printer Card. This uses a 40 column electrosensitive matrix printer, and allows "push button" printing of the EPROM/RAM/Intercursor contents from the SOFTY card. The number of characters per line is selectable, from 1 to 16 bytes. A spare EPROM socket is provided for user programs eg. disassemblers etc. Supplied built and tested, the price is £166·75 inclusive of VAT and post and packing.

Both products are available ex-stock. Full details are available from **GP Industrial Electronics Ltd, Skardon Works, Skardon Place, North Hill, Plymouth P14 8HA. Telephone (0752 28627.)**

BUDGET SOLDERING AIDS

Tri-tronic Marketing of Rugby have introduced three soldering aids which, even if you buy all three at once, won't break your bank.

Their British-made Type 1 Soldering Iron is only 18 watts, yet its output is comparable to that of most 25 watt irons. Also, it is only7·7 inches long and weighs just 4·25 ounces, so that it is ideally suited to the hobbyist. The iron comes complete with a $\frac{1}{8}$ inch diameter bit and 6 feet of cable, and is priced at £4·72.



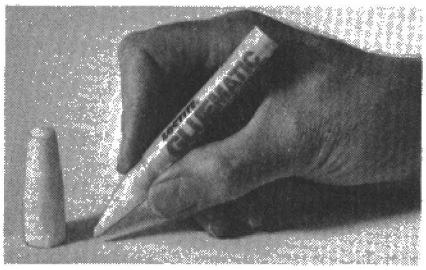
To complement the iron, a robust bench stand is available, finished in red anodised aluminium, and complete with cleaning sponge. The price of the stand is £4·78.

Also available from Tri-tronic is a professional grade de-soldering braid which is used by many major electronic equipment manufacturers. The braid is vacuumised for high speed reaction and incorporates a non-corrosive flux. For either 0·8mm or 2·2mm width braid, the price for a $5\frac{1}{4}$ foot reel is 94p.

All three prices quoted above include VAT and p&p, and the products are available from: **Tri-tronic Marketing Ltd., 75 Albert Street, Rugby, Warwickshire, CV21 2SN.**

COMING UNSTUCK

If, like many people, you have been put off using instant "Super-glues" because of the annoying habit the glue has of finding its way onto the wrong surfaces (fingers in particular), you will be pleased to hear that Loctite have come up with a remedy to the problem. Their "Gluematic" is an effective dispenser which enables one to control the flow of glue so that anything from a pinhead to a large blob can be deposited. This is effected by means of a spring-loaded applicator tip. Light pressure on the tip releases a small amount of glue, and the flow increases with heavier pressure on the tip. A childproof twist/lock safety cap is also incorporated.



Undoubtedly, the Gluematic makes the use of instant glue much safer and more controllable. It retails at £1·75, and is available from hardware and DIY stores, and branches of Woolworths.

DIGITAL PANEL METER

A digital panel meter which is microprocessor compatible has recently been introduced by μData Systems. Their MP12T combines a $4\frac{1}{2}$ digit liquid crystal display with a 12 bit binary data interface.

Tri-state TTL compatible outputs are byte organised, enabling it to be used as a direct memory-mapped interface to a microprocessor. In addition, full UART handshake logic is incorporated, and a further count-serial output enables two-wire data transmission and minimum cost high voltage isolation.

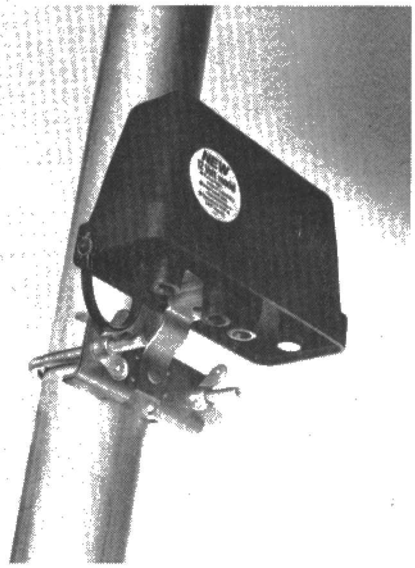
Precision timing is provided by a 6·5536 MHz crystal oscillator and the band-gap reference voltage has a temperature coefficient of 20ppm. Accuracy is 0·025 per cent and sensitivity is digitally adjustable between 10μV and 500μV per count via the Trescex expansion system.

The price for one-off is £79 + VAT, and further information is available from: **John Nichols μData Systems, Office Suite 1, Coach Mews, The Broadway, St. Ives, Huntingdon, Cambs. PE17 4BN. (0480 63570)**

TV BOOSTERS

Antiference recently announced the introduction of two new high powered masthead amplifiers for TV/FM reception, together with an associated power supply unit. They are the UP2300 (15 dB gain), the UP3300 (27dB gain), and the PU1240 power unit.

The new amplifiers incorporate entirely new sophisticated active devices which operate at 12 volts d.c. with power supplied via the downlead. They provide extremely high output capability and improved gain characteristics, and have separate VHF and UHF inputs. Both amplifiers are housed in a weatherproof moulding which is designed for mast or surface mounting. The power unit has been specially developed for remote powering of the two amplifiers, and provides a stabilised 12V d.c. negative earth supply.

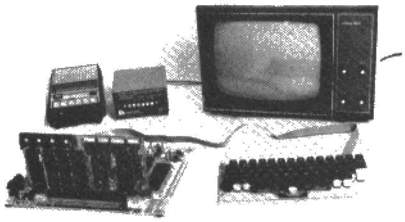


All three models are avilable from usual stockists, and approximate prices are: UP2300–£16; UP3300/£23; PU1240–£15.

Antiference Ltd., Aylesbury, Bucks HP19 3BJ (0296 82511)

EXPLORER 85

Newtronics the computer section of HL Audio are the sole distributors for the Explorer 85 microcomputer system. At the heart of the system is the new 8080A chip from Intel and the MPU is compatible with the vast repertoire of 8080 based programs.



The EXPLORER 85 is meant to form the centre of a "Main-Frame" type computer system—its basic board has room for 4K RAM, 8K ROM/EPROM, two fully buffered and decoded S-100 Bus sockets, ROM-I/O chip to hold the system monitor, two 8-bit 1/0 ports, cassette-file interface. An S-100 expansion frame, which bolts rigidly to the basic board, gives six S-100 slots which will allow standard S-100 boards to slide in for any available function.

The system comes in many levels, but for £297 plus VAT Newtronics will sell you a kit for levels A, B and D plus a video terminal board with ASC11 keyboard for direct access to a TV or video monitor. This gives the user 4K RAM, a very powerful 2K ROM-based Machine-Code Monitor, two S-100 Bus slots (to run anything from extra RAM to discs), ASC11 input, Video/TV output, cassette-based files, plenty of parallel and serial I/O ports.

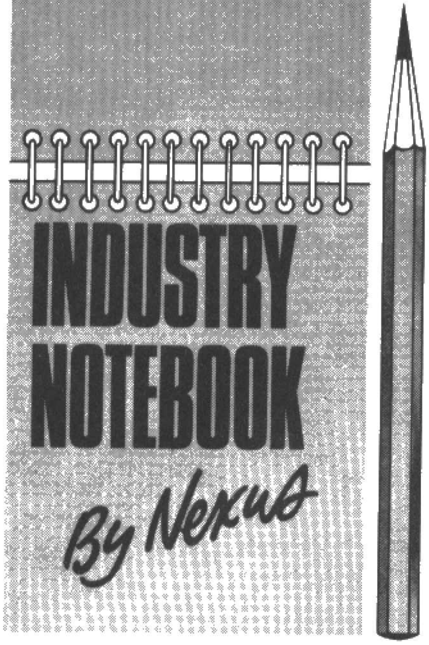
Newtronics Ltd., 138 Kingsland Road, London E2 88Y.

HOME RADIO

With the ever increasing cost of batteries many constructors will be interested in the battery eliminator kit for a PP9 available from Home Radio. This kit which can be assembled in a matter of minutes using a screwdriver and only requires a 13 amp plug. The complete unit can be inserted into an old PP9 battery case or a suitable case can be provided for an extra £1·50 plus VAT.

The kit is priced at £2·80 including VAT and p&p.

Home Radio (Components) Ltd., 234-240 London Road, Mitcham, Surrey, CR4 3HD.



INDUSTRY NOTEBOOK

By Nexus

Youth at the Helm

Full marks to 33-year-old Alan Sugar for getting Amstrad Consumer Electronic Ltd off the ground with a successful public flotation. As a by-product, if he wasn't one already, he became a millionaire, at least on paper, and good luck to him.

He started his company at the age of 21 as a wholesale distributor of car accessories but soon after spotted an opening in the burgeoning hi-fi industry, first in making tinted dust covers and then into amplifiers and the rest. Today Amstrad has a full range of equipment for home and in-car entertainment and host of new products in the pipeline for release this year and next.

It reminds you of William Morris starting off with his bicycle repair business in Oxford and finishing up as Lord Nuffield although, in this case, I should hate to see Amstrad in the sorry state that has overtaken the once-proud Morris and Austin marques within the present BL Cars. A better example is the young Bill Hewlett and Dave Packard getting together in the backyard to form what today is the mighty Hewlett-Packard organisation. Or, for that matter, the young Marconi, who, at the time, appeared to be off his rocker, the complete nut-case and an Italian one at that.

What is so extraordinary about Alan Sugar is not that he is still young and clearly talented in business matters but that he moved into a sector in which most British companies were fighting a rearguard action in face of increasing threat from Far East sources, principally Japan. It seems to me that Sugar wasn't a fool who rushed in but an astute operator who used the opposition to his own advantage. It was they who established the market, he who found the slot in quality and price, the simple formula with sales appeal. He may, too, have taken a leaf from the book of Clive Sinclair in using sub-contractors to make much of the product line to his designs and yet avoiding the mistakes which led to the failure of the old Sinclair Radionics.

Every business needs a bit of luck. Sugar's came with the pound gaining strength while the yen weakened. Still, which ever way you look at it, Amstrad is an achievement which shows that anyone with guts can still have a go at running his own show. It also dispels the depressing myth that we can't compete, although it has to be admitted that a percentage of Amstrad equipment is imported—from the Far East!

Fears

Apex, the white-collar union, has called for a 30-hour week, more basic pay, longer holidays and early retirement. Terrified by the prospect of the electronic office and a supposed slackening of demand for clerical staff, Apex is naturally out to protect its membership. And yet there are plenty of examples where resistance to new ideas and methods by a workforce has resulted in bankruptcy and no jobs at all.

There is bound to be greater productivity, possibly job loss, in the electronic office. That's what it's all about but I often wonder if the case is not overstated. Not many years ago there was uproar over computers being used for generating pay-rolls and other routine and boring office tasks. But there was no mass unemployment, only a quick and happy adaptation with a new field of job opportunities automatically opened up for operators and programmers, not to mention all the work generated in building the computers, installing them and servicing them during their lifetime.

Finniston

It now seems clear that nobody is really happy with the reforms in the engineering profession as proposed in the Finniston Report. The civil engineers have even gone so far as to say that their inclusion in the new Engineering Authority, if it ever gets set up, would weaken their international standing. Other interested parties are not nearly as high and mighty. But there are some oddly phrased statements being bandied around. I see Mr John Sampson, general secretary of the UK Association of Professional Engineers, is quoted, for example, as saying, 'The top level muscle required to drag industry and the establishment into the engineering dimension can only be effectively wielded by a very highly respected individual reporting direct to the prime minister.' Who does he have in mind—could it be Mr John Sampson?

The debate continues and the problem, if there is one, remains. The mountains of paper work resulting from Finniston should keep some Apex clerical workers busy for a few months—and that can't be bad.

Mystery

Sealed lips are the order of the day in the mystery of Inmos, GEC/Fairchild, the NEB, and the Government. A year ago everything looked all set for two British-based large volume IC manufacturers to be in production this year and next. Whatever may be happening behind the scenes nobody is prepared to admit.

But there is plenty of speculation. Is Schlumberger, now owner of Fairchild, disenchanted with the idea of the joint GEC/Fairchild project? Is the recently reorganised NEB, not to mention the Government and, particularly, Industry Minister Sir Keith Joseph, disenchanted with the idea of Inmos? Is it really on the cards that GEC's Sir Arnold Weinstock has been contemplating investing in Inmos, thus relieving the problem of further taxpayer funding?

Kite-flying is rampant, permutations of possibilities almost endless.

Meantime, what we would all like to know is exactly how Inmos has spent its first £25 million. What are the circuits, where are they, and how and when will they be marketed?

I ask only because I have read that a vice-president of record-breaking Intel has forecast that what with inflation and the expense of the very latest technololgy it could cost $50 million to build a fabrication plant by 1985. The vice-president is Willard Kauffman in charge of Intel's component production. He should know what he is talking about and by my reckoning $50 million at 1985 prices is a lot less than £23 million which is today's equivalent.

Inmos, of course, hasn't started building yet. True, there has been reported pilot production in the USA but how does this help Britain? True, there is an engineering and administration staff in the UK at Bristol. But still no product and no production. How about a little public accountability? Inmos and the NEB surely have a duty to let the shareholders (i.e. we the taxpayers) know the current state of play.

Awards

It wasn't just the technology and export achievement of Decca that Racal bought. Racal got Decca's previous Queen's Awards to Industry as well. The Racal Group itself scooped up another three this year, one for technology and two for exports, bringing their score to 13. Add in the ten held by Decca and the Group including Racal-Decca now has a grand total of 23.

Strangely enough, one of the export awards went to a non-electronics product, the Airstream anti-dust safety helment. It co-incided with the 100,000th to be produced (50 per cent exported) and this particular figure was hit two years, yes two years, ahead of the original target. This is the sort of good news that keeps Racal rolling. Other companies please copy.

sinclair ZX80 REVIEW

By MIKE ABBOTT

PRODUCED by Science of Cambridge, the ZX80 is undoubtedly excellent value for money, whether purchased as a kit or ready-built. The Z80 based system incorporates a UHF modulator so that it can plug directly into your television aerial socket and go! All you need is a 9V 600mA unregulated supply. All leads are supplied, including that for a domestic tape recorder, to allow use of its built-in cassette interface for saving programs. Memory expansion is available up to 16K bytes, but the basic machine has 1K byte of RAM which Sinclair claim is used so efficiently that it's equivalent to 4K bytes on a "conventional" computer. We did not check this, but Sinclair also claim that the ZX80 is faster than all other personal computers, and so a comparison was made between a Commodore PET, our UK101 and the ZX80, each working through a simple benchmark test chosen to be independent of their different dialects of BASIC. The winning order was: ZX80, UK101 and PET.

FIRST IMPRESSIONS

The case comes in two halves, which fasten together with plastic rivets to form a pleasant unit in appearance, measuring 175 × 220 × 35 mm. These lightweight pressings are about as robust as plastic egg cartons, however, and it is immediately apparent that the p.c.b. gives strength to the case, rather than the reverse. Although there is a regulator with heatsink, the ventilation slots seen in the photograph turn out to be printed black stripes in reality. The case is probably not strong enough to take real slots! Affordability is the name of the game, and so mere adequacy should not be criticised, particularly as the all important p.c.b. is of *excellent* quality and design, in the ZX80.

The touch sensitive keyboard is fabricated integrally on the p.c.b. and looks smart enough. Membrane switches are used, and these sensitive and easy to clean keypads seem likely to enjoy increased popularity in the future.

CONSTRUCTION

Assembly was self-explanatory, with little risk to the i.c.s because the soldering stage involved mainly sockets and discrete components. A separate leaflet giving assembly instructions is supplied, and this is fairly thorough. It gives, in addition to the assembly procedure, convenient component identifications and colour codes alongside each item in the components list. With 47nF capacitors stamped as 473Z etc., the beginner will appreciate this.

At this stage I would like to reveal the fact that my ZX80 did not work initially due to a construction error on my part. In the belief that my kit was two diodes short, I had made up the deficit with surplus ones, only to find that the short-fall was due to my having put two diodes in what were intended to be vacant positions. If time is not on your side, mistakes like this are all too easily made, and so I proffer this warning. If at the end of the day your ZX80 fails to operate, check not only that components are in the right place, but that there is nothing where there shouldn't be! It costs £10 to put this microcomputer through Sinclair's debugging system—PE did not receive a bill, but you will!

UP AND RUNNING

Deviations from the norm are manifold in the ZX80, and this has made the machine fun to review but difficult to know where to begin.

A manifest curiosity relates to the keyboard, and what Sinclair describe as "key word" entry at a single touch. This refers to such words as INPUT, GOTO, RUN, LIST etc, being printed on the screen by one key press, and is claimed to save you up to 40 per cent typing time, although it must depend upon whether you are developing, or merely running a program. Many "key words" do not begin with the letter of the key to which they are assigned, which can lead to a conflict with one's own reflexes to begin with, that is if you are used to pecking out words like GOSUB in the old fashioned way.

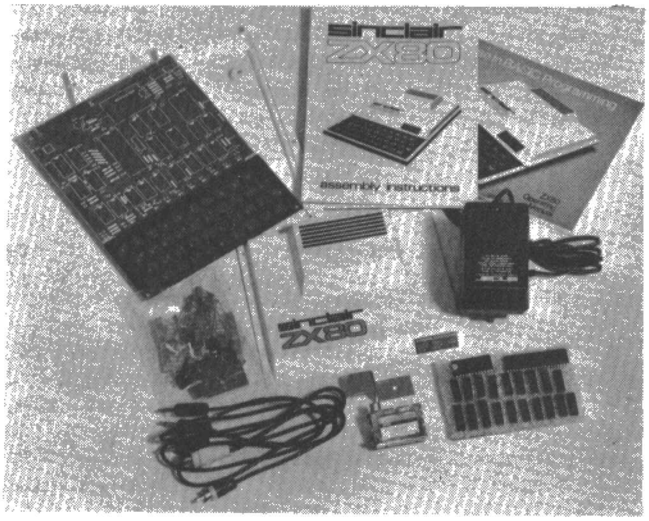
There is a kind of "anticipation logic" associated with the keyboard too! If you take, for example, the U Key; this has three functions. With Shift, it prints the dollar sign, and without Shift it prints U. It can also print IF, but just how can a two-condition switch provide three functions? Well, the key assignments are cleverly arranged so that the machine can assume certain needs. In the case of the U Key, there is no legal way in ZX80 syntax, that a U can follow a line number, and so the "anticipation logic" assumes you want IF . . . and that's what you get! All other key words are juggled thus.

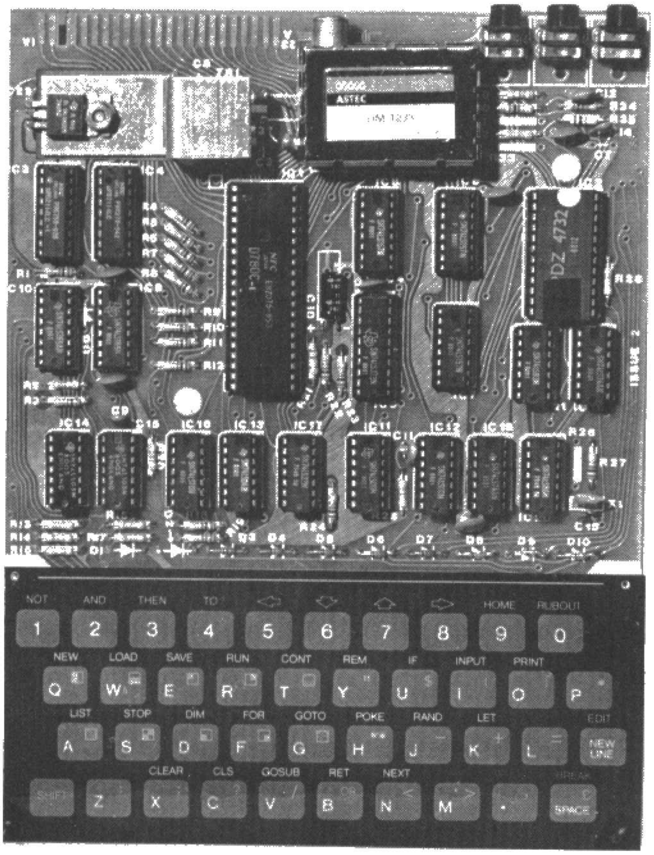
Some of the inflexibilities of the ZX80 may stem from the aforementioned. Only one instruction per line is allowed, and LET is not optional. If it was, you might start a line with U = X + 1, which would confuse the "anticipation logic".

THE DISPLAY

Large clear characters appear on a rock steady display in reverse field video (black characters on white background). A full screen contains 32 columns by 24 rows of characters, and amazingly enough, the VDU operating firmware does not facilitate scrolling. When a full screen is reached, if your program does not execute a *Clear Screen* instruction (CLS) before undertaking further printing, it will "kick out" and throw up the *Screen Full* error message.

At each and every keystroke there is an extremely irritating flicker on the screen, particularly when typing in NEW, which causes a complete eruption. There is no key-repeat function, and when repetitive "dabbing" at any of the membrane switches is necessary; Rubout, for example, concentrating one's eyes on the restless display becomes difficult.




NOT AND THEN TO HOME RUBOUT
1 2 3 4 5 6 7 8 9 0
NEW LOAD SAVE RUN CONT REM IF INPUT PRINT
Q W E R T Y U I O P
LIST STOP DIM FOR GOTO POKE RAND LET EDIT
A S D F G H J K L NEW LINE
CLEAR CLS GOSUB RET NEXT BREAK
SHIFT Z X C V B N M . SPACE

There are ten special graphics characters accessible direct from the keyboard, each available in reverse video by printing the appropriate CHR$, thus providing twenty fairly standard graphics symbols of the kind found on larger machines. Producing bar graphs is quite feasible.

The video display is not memory mapped. In fact, with a total of only 1K of RAM there is no way the VDU could be memory mapped, since 768 locations would be snatched away for screen refresh alone. The processor presumably returns to PRINT statements on an interrupt basis, which would explain why the screen goes blank during any processing—such as FOR/NEXT loops—and this places animated *real-time* graphics outside the realms of possibility. Many disadvantages may result from this.

EDITING

Microcomputers running an interpreted BASIC generally have a small vocabulary of error messages, such that if a program with an error is run, when the mistake is encountered, the machine will stop and display the appropriate message. This might read:

SYNTAX ERROR IN LINE 150
or UNDEFINED STATEMENT ERROR IN LINE 70 etc.

Many machines have numbered error codes which amount to the same thing, and although no computer can comment on the logic of your program, it *can* tell you where you have entered invalid instructions—*after* you have tried running the program! This is where the ZX80 differs, at least in the case of syntax, because it will not accept a line in which you have a syntax error, at the *programming* stage.

The cursor plays an important roll in this function because it can enlighten you the moment you make a mistake, or merely remind you that something needs correcting sooner or later. Let me give you an example.

Supposing you wish to type the following instruction:

10 PRINT “SOFTWARE RULES OKAY”

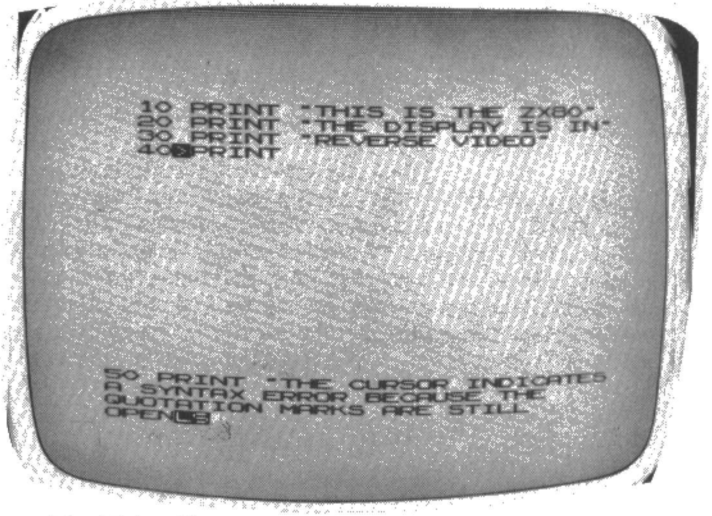
The normal cursor awaits at the bottom of the screen:

K

You type in:

10 PRINT L (three key presses)

The cursor suddenly turns into a reverse-field L. Note that the cursor symbol is described as reverse-field *relative* to the ZX80's normal display.



```
10 PRINT "THIS IS THE ZX80"
20 PRINT "THE DISPLAY IS IN"
30 PRINT "REVERSE VIDEO"
40>PRINT

50 PRINT "THE CURSOR INDICATES
A SYNTAX ERROR BECAUSE THE
QUOTATION MARKS ARE STILL
OPENLS
```

The L is telling you that the computer is not expecting any further single-touch key words. This relates to what I described earlier as “anticipation” logic, so that, using the former example, the U Key would actually print U now, and not IF. In other words, the cursor reflects the computers expectations.

To continue, opening quotes are now needed.

10 PRINT “LS

Now you find yourself with a two-character cursor clumsily lopping along. The S stands for Syntax error, and while it is present, the line will not be accepted. If you were to hit New Line (Return) now, nothing would happen, and this is because you have opened quotes and not yet closed them.

To finish, typing the remainder gives

10 PRINT “SOFTWARE RULES OKAY” L

Pressing New Line now sends line 10 to the top of the screen to join any previously written lines . . . A “*greater than*” symbol always points to the last line entered.

This leads automatically to discussion of the Editing firmware. Two arrows, obtained by Shift 6 and 7, allow the > symbol to be moved up and down the listing to select the line to be edited. After pressing the Edit key, two further arrows, Shift 5 and 8, allow the cursor to be moved *along* the Edit line, which by now will have appeared at the bottom of the screen. Insertion, alteration and deletion of characters in the usual way is then possible.

You may be wondering how lengthy programs are listed on a machine with no scroll capability. In short, there *is* a scroll which can be executed incrementally on a listing by moving the > symbol downwards using the "downward arrow" key. When the > symbol (which, incidentally, is called the *Current Line* Cursor) hits the bottom line, it scrolls the listing from then on.

Hyphenated LIST commands are not valid for listing blocks of program, but, according to the manual, if you type LIST, followed by a line number, the machine will list your program from that line down to the bottom of the screen. My machine seemed to have a mind of its own about that! I always got the line I wanted, but embedded in a block of program listing of the machine's own choice. If I asked for LIST from a line number already displayed further down, I got the same program block back with the Current Line Cursor readjusted to that line. Fair enough I suppose!

There is in the manual an explanation of the computer's logic for listing specific lines. This seemed little help to me when seeking out certain blocks of lines.

ZX80 BASIC

The ZX80 can only perform "integer" arithmetic; that is to say, whole numbers. Calculations on low value figures can therefore produce pretty meaningless results unless you have implemented a software solution—which is easy enough although heavy on memory! This means that the machine will not accept a decimal point in a listing (the dreaded S appears). It is interesting to note that the S came up even when I tried to reply to an INPUT with a number containing a decimal point. That cursor is ever vigilant! Any number which contains a decimal point as a result of an algorithm will be truncated, even at an intermediate stage. An example, for readers who are not familiar with the limitations of integer arithmetic:

```
10  LET A = 5/2
20  LET A = A*2
30  PRINT A
    gives the result 4
```

Enough criticism! There is one versatile aspect of ZX80 BASIC which impressed me, and that is GOTO n, where n can be a *variable*. This, I think, does more than compensate for the absence of ON n GOTO, found on other machines.

I decided not to waste editorial space repeating facts about the ZX80 which can be found in Sinclair's ubiquitous two-page advertisements, but to confine this review primarily to subjective judgements. For this reason there are no lengthy lists of BASIC verbs and functions here. There are indeed no mathematical functions, although the manual shows how square roots can be resolved by software.

There are a couple of novel string functions, and these are:

TL$ *(string)*	which returns the string contained within the brackets minus the first character.
CODE *(string)*	which returns the code number of the first character in the string. *This is not the ASCII code*!!!

The non standard ZX80 character code table is given in the manual, and it is interesting to note that complete key words such as CONTINUE, RANDOMISE, CLEAR etc., can all be thrown up on the screen by a single PRINT CHR$ *(code number)* statement.

A pseudo-random number generator allows the following functions:

RND(X)	which provides a random interger in the range 1 to X.
RANDOMISE	which initialises the random sequence to a number, using the number of frames supplied to the television since it was switched on. This eliminates the likelihood of a random number based program following the same trend each time the machine is switched on.
RANDOMISE n	which sets the start of the random number sequence to n. This would be useful if you wanted a random number based program to deliberately do what RANDOMISE avoids, i.e. repeat a pattern or trend each time after switch-on, or execution of this function.

The ZX80 *advertisement* refers to a "Timer under program control". This refers to the PEEKing and POKEing of the TV frame counter, and not standard BASIC real-time.

Undoubtedly software and expansions for the ZX80 will be forthcoming, but for the benefit of those who know absolutely nothing about computers, yet have read the Sinclair *advertisement,* in its minimal form you would at present be hard pressed to run a power station or even play chess with the ZX80.

Another claim which might mislead the novice is: *"Lines of unlimited length"*. They may indeed be! But this can only be in the form of extended PRINT statements or prolonged Boolean expressions, such as:

IF A = 1 OR A = 5 AND K = 6 . . . etc.

This may be very handy indeed, but the hidden truth is that only *one statement per line* is legal, thereby relegating the colon to its literary function only.

Some ZX80 statements are: ABS(n), REM and STR$(n). There is no TAB function, although a software implementation of this is given in the manual.

Other minor observations are that NEXT must be followed by the operator; NEXT Z for instance. INPUT statements may not contain messages or prompts between quotes. For example:

INPUT "NAME"; N$

is illegal. A prior print statement would be necessary for "NAME?"

INPUT statements can only handle single variables. For example:

INPUT X,Y,Z

is illegal. You would require three separate INPUT statements to do this.

With regard to speed, a quick check was carried out to verify Sinclair's claim to processing speed. Below is the program used, and the time taken by two other machines which happened to be available at the time.

```
10 FOR A = 1 TO 5000                      TIMES
20 LET X = A*2
25 LET X = X/2           ZX80             30 sec.
30 NEXT A                UK101            40 sec.
40 PRINT "FINISHED"      PET              50 sec.
```

It should be borne in mind that the ZX80 had the advantage of processing integer only arithmetic, but Clive Sinclair is quoted as saying that, with its clock speed of 3·25MHz, the ZX80 will *remain* faster when used with the *floating point ROM* which is now in the pipeline. This ROM, incidentally, will incorporate logarithm and trigonometry functions too.

HARDWARE

The unit measures 218 × 170 × 50mm and weighs 340g (12 oz.), and is based on the NEC Z80 µP.

All firmware is stored in one ROM, christened the "Super-ROM". This i.c. houses the *BASIC interpreter, operating system, monitor and character set.* A 46-way edge connector pad (23 + 23 pin) at the edge of the p.c.b. allows for expansion and interfacing. Memory expansion boards are available which can add up to 3K bytes each.

There is no PIO (Parallel Input/Ouput) device on-board. The polarized expansion connector carries the Address Bus and Data Bus, along with the Z80's "single wire" control lines.

Memory comprises two 2114L RAMs; the remaining i.c.s, excluding the regulator, being 74LS series TTL devices.

OPERATING MANUAL

The ZX80 Operating Manual is dubbed "A Course in BASIC Programming". It contains minimal inside information about the hardware and firmware and so would displease the "wires and machine code" man, but instead is an excellent introduction to BASIC, or at least, the ZX80's dialect of the language.

There is little one can say about this as a training manual because it is so good! It is well printed, clearly laid out, and very considerately written for the beginner, and it has some quaint chapter titles. A latter chapter called "4K BASIC FOR ZX–80" gives a summary of the "user's view" of the machine, and for the technically hungry, an elementary "computer's eye view" of how things are organised. There is also a glossary of terms and statements. The appendix gives a number of useful address locations in the ZX80's memory.

So, the ZX80, plus this manual, will make learning BASIC easy and pleasurable. Although there are many more instructions at your finger-tips with an extended BASIC, they are the ones which make programming *easier,* and so learning the language with Sinclair's package should nevertheless be effective and worthwhile.

CASSETTE INTERFACE

The cassette interface is Sinclair's own (300 baud), and conventional SAVE and LOAD commands are used to write and read data using a domestic cassette recorder. There is no VERIFY or *named program* firmware, and curiously for a machine of this kind, *variables* and *data* are SAVEd too; after LOAD you should start with GOTO 1 instead of RUN to get the benefit of this.

The manual implies that you may not record successfully with your cassette player running on mains power, and that you may need to switch to battery power. I did not have this trouble, but using a Sony TC–207, recording programs could not be achieved with the Earphone lead connected simultaneously with the Mic. lead. The earphone plug had to be removed. I later discovered an addendum slip to this effect.

The display, unrefined as ever, produced ugly patterns whilst cassette handling.

CONCLUSION

I see the ZX80 in the classroom, and in workshop control applications. Perhaps even hidden in the executive's top draw, to be pulled out at lunch times to resume training. For these situations, the machine is excellent, and eminently suited to teaching children the art of computer programming. It is of little use scientifically at present, with only integer capability and no mathematical functions, and this to some extent wastes the boasted processing speed of the machine.

At the time of writing it seemed appropriate to advise that a firm delivery date be secured before purchasing the ZX80 microcomputer.

A ZX80 Users Club has been formed, membership of which costs £6 p.a. (£10 overseas), which includes the newsletter and the Software Bank Index. For details, write to:

ZX80 Users Club, PO Box No. 159, Kingston upon Thames, Surrey KT2 5UQ.

POINTS ARISING

AMMETER *(December 1979)*

Fig. 7, component layout. There are two R1s, so the most central R1 should be altered to read R7. There are also two D13s. The end-mounted diode is D13, and the flat-mounted one should read D15.

The supply leads should, of course, be taken from Chassis, and the Ignition Switch (non-battery side).

NOTE ADDED TO P.E MARCH 1980 OF (III)

DIGITAL FREQUENCY METER *(March '80)*

The p.c.b. layout in Fig. 10 shows pins 26, 27 and 28 of IC11 linked to another track. These pins are not used and it is therefore necessary to break and isolate the tracks from pins 26, 27 and 28.

In Fig. 13 the link from S2b to diode D4 should be taken to the right-hand side of D4 and not the left as shown.

Some of the connections to the multiplexed l.e.d. display in Fig. 7 are incorrect, the pin numbers should be in ascending order from 1 to 16 (from left to right). The p.c.b. layout is correct.

SEE ALSO P.E. SEPT 1980 P.21 OF (F)

Semiconductor UPDATE...

FEATURING ICL 7660 TDA 1099 SP LS 7220

R. W. Coles

NEW VOLTS FOR OLD

How many times have you put together your ideal circuit and then discovered that just one of those naughty chips needs a negative supply? Own up now. It happens to me all the time!

In the past you either had to redesign the whole thing using cunning tricks and five volt OP-AMPS like the LM324, or you gave in, added some noughts to the cheque and built a new power supply to suit. If you could stand the cost, the board space, and the resulting noise and inefficiency you *could* have used a switching DC to DC convertor, but that was never an attractive solution where only a low current negative rail was required to bias one or two chips.

Enter the ICL 7660 from Intersil, problem solved. This cunning new device turns any positive voltage you give it into an equivalent *negative* voltage. You've only got a plus five volt logic supply? Well, with the ICL 7660 in circuit you've got a minus five volt supply too, so you can power those phase-locked loops or that A to D convertor. A twelve volt car battery? You mean plus *and* minus twelve volts, ideal for those 741 OP AMPS.

The doubting Thomas's among you are no doubt saying you've heard it all before, and next you expect to hear about the £20,00 price tag. Not so with the ICL 7660, in hundreds it costs only £1.23 (OK, so you don't want a hundred, let's say about two quid then). Think it's bound to be big? Forget it, this little performer comes in a plastic eight pin mini-clip! OK, OK, so how much does the transformer cost. You don't need one, just two 10 MFD capacitors, *and* you can draw up to 40 mA.

Intersil haven't told me how the thing actually works, but it's a fair guess that they chop the positive supply up with a CMOS switch, pass it through one of those capacitors to destroy the DC level, and then rectify it and smooth it with the other capacitor. I don't want to take my guesswork too far, but it's likely to be a synchronous switching rectifier, rather than a diode, to avoid the otherwise inevitable diode drop. A synchronous rectifier would also explain the very high efficiency of up to 98% with a 5K load.

If you need, say, minus ten volts from your 5 volt logic supply don't despair, just cascade two 7660s and you are in business. 40mA not enough current? Then wire some 7660s in parallel, easy isn't it! If you aren't into analogue circuits at all, then think how this device could provide the negative supply for those dynamic RAM chips, or that RS232 interface, or . . .

MANY LEGGED BEASTIE

One tends hardly to raise a yawn these days, on encountering yet another weird and wonderful I.C. package, but the TDA 1099 SP from Thomson CSF had me checking the biro mark on the bottle of Johnnie Walker just in case I had tipped too much into my glass. With the (modest as usual) consumption verified, and after a couple of blinks, yes it was true. The TDA 1099 SP really did look like a plastic power transistor, but with no less than *eleven* pins, all in a neat row. Further investigation showed that the TDA 1099 SP is actually a dual (stereo) audio power amplifier in a single package which provides a very creditable ten watts per channel into 2 ohm loads. Especially designed for car radio systems, this new chip appears to be virtually indestructible.

I blanched when I read about the conditions it is designed to withstand, because I had no idea that a 12 volt car system could inflict such nasties on our unsuspecting electronics.

The TDA 1099 will handle:

(i) 50ms, 40 volt transients.

(ii) Extended operation at 28 volts.

(iii) Normal operation at 18 volts (possible if you get regulator problems).

(vi) Short circuits on the outputs.

(v) Polarity inversion. (Garages sometimes connect batteries up the wrong way round, the TDA 1099 SP will stand the current until the fuse blows!)

Despite this macho image, the new chip will provide a very lady like fidelity for those who enjoy that kind of thing in their cars. Distortion is typically only 0·2% at 4W, cross talk is at neg 60dB, the bandwidth is well beyond my appreciation at 20KHz, and the signal to noise ratio is 75dB even at full power.

The package design is unique and Thomson claim that it is well suited to the rugged enviroment to be found in a car.

QUITE A COMBINATION

There have been quite a number of circuits published for ingenious electronic combination locks, but most have suffered from their need for numerous ICs (usually TTL or CMOS) and a host of support components. You can reduce the chip count by using a micro' of course, but this is overkill with a capital 'O', unless you can use the spare capacity of the processor for other jobs too. There has been a need for some time for a simple, cheap, combination lock circuit based on a single dedicated chip, and now at last someone has done something about it.

The firm is LSI Computer Systems Inc. (Quite a mouthful) and the chip is the LS7220. This new chip has been designed primarily for automotive applications, to replace the ignition key for example, but there is no reason why it should not be pressed into service anywhere that a convenient security lock is required. The LS 7220 comes in a 14 pin plastic DIP, and will run from 5 to 18 volt supplies with a very low consumption (40 microamps maximum at 12 volts). You would normally wire the chip up to a keypad where any four of the switches are wired to inputs I1, 2, 3 and 4, and all unused switches are wired to the RESET input. To open the lock you have to hit only the four valid keys in exactly the right sequence. If you get it right, a lock control output switches to control a relay and presumably a solenoid lock. An additional output is provided to control a lock status indicator LED. Four keys used in this way provide 5040 sequence possibilities, not sufficient for the Crown jewels perhaps, but adequate for many day to day applications. As with all practical car security systems, there can be a problem if you need to let someone else have access to your vehicle, to park it perhaps or to service it. The LS 7220 removes the need for you to give these casual users the combination by providing a SAVE input which, in effect, allows you temporarily to disable the lock once you have 'Logged-on' with the correct combination, even though you may turn the ignition off and leave the car. Turning off the ignition without using the SAVE feature causes the lock to operate, but fortunately a pin is provided for a 'Convenience delay' capacitor so that you can actually escape from your car before the lock imprisons you!

It all sounds terribly complicated to me, and I wouldn't want one on my car, but I might just find a use for it on my piggybank. You can get the LS 7220 in the UK from Radiofort Sentex Ltd., Radiofort House, 73A Shenley Road, Boreham Wood, Herts. (01-207 1957).

VIDEO The slow revolution

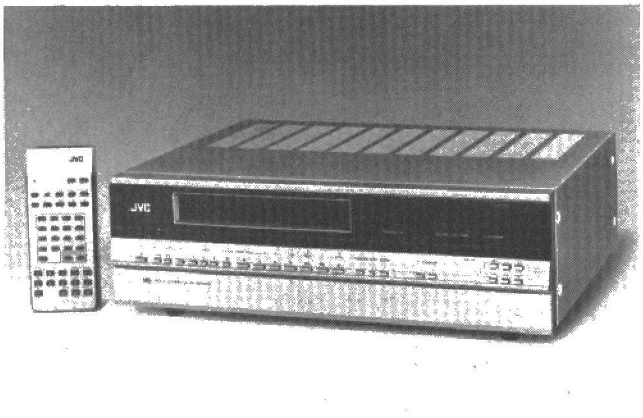
R. Miles

THE proliferation of home video recorders which seems to have taken many people by surprise is merely the latest stage in an evolutionary process that began in earnest thirty years ago—just after the Second World War, that had seen tremendous advances made in electronics. Many of these being applicable to television, which had been neglected during those years—even in America. The time was ripe for new developments. Companies that had been working on wartime contracts now found themselves out on a limb; looking for new products to fill their production capacity, and provide work for the returning thousands. Some came across the Magnetophon: Telefunken's audio recorder, used by wartime German radio stations and taken by the Allies as reparations.Thought, turned into action.

MAGNETIC TAPE DEFICIENCES

The result was that all sorts of deficiencies in the magnetic recording process were made apparent that the limited requirements of the audio signal hadn't revealed. To cope with the very high upper video frequencies for example, required either an incredibly small head gap or a phenomenally high writing speed. In the event, because the materials then available to designers didn't allow head gaps to be reduced by the necessary amount, writing speeds of up to 40m/sec were used, which caused both wear problems and used up enormous reels of tape very quickly.

It also became apparent that the video signal couldn't be recorded directly onto the tape if the bandwidth was to be recovered in its entirety. In fact, only a little more than half proved recoverable. The fault lying with the playback head. Where the directly proportional increase in its output with frequency at the rate of 6dB/octave, could continue only until either the resonant frequency of the head was reached or the wavelength approached the width of the head gap, when the output would rapidly collapse to zero, while at the bottom end of the frequency scale, the correspondingly low output tended to merge in with the system noise. The difference between floor and ceiling being a constant 10 octaves; whereas 18 octaves were necessary if a well defined picture was to be reproduced—say 20Hz to 5MHz.



The microprocessor controlled HR-7700E is JVC's latest and most advanced VTR.

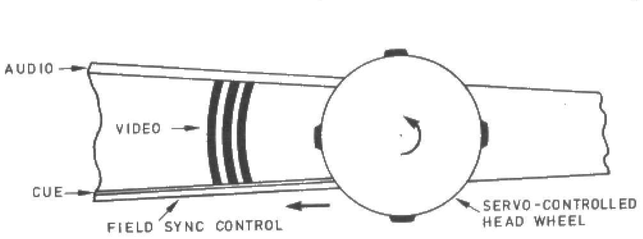
Two approaches were tried. In one, the bandwidth was divided up into two or more frequency spectra. While in the other, it was modulated onto a fixed carrier frequency. VERA, the Vision Electronic Recording Apparatus developed by Mr. Peter Axon for the BBC, used both; the low frequencies—from near d.c. to 100kHz—modulated the frequency of a 700kHz carrier, while the high frequencies—from 100kHz to 3MHz—were AM recorded onto a separate track (a 3MHz bandwidth being quite adequate for the monochrome 405 line system). Audio, was also recorded FM, on a parallel track. The tape/writing speed was 5m/sec; tape width—12·7mm. Running time, 15 minutes.

AMPEX

Several other recorders of similar design were under test. But it was Ampex, experimenting with rotary head designs, that in 1956 would win the race with their four head (Quadruplex) recorder; for the writing speed could be very much higher (41·148m/sec European broadcast standard) and the tape speed very much slower (39·7cm/sec EBS). The entire video signal was frequency modulated onto a carrier, so that the bandwidth necessary to carry the information was now determined by the sidebands produced, which could be held down to around 4 octaves. An additional advantage was that limiting could be applied to counter amplitude changes at such high writing speeds.

However, the complexity of the rotating head system that had made success possible, Fig. 1, now militated against the recorder's use in other than broadcast applications. There was little room for tolerance. Four heads spaced 90 degrees on the periphery of a wheel, spinning at 250 r.p.s., perpendicular to the motion of the 50mm tape. The tape formed into a curve of just over 90 degrees around the headwheel by a vacuum guide. Each head laying down transverse tracks containing 16 lines of video information with 2 lines of overlap. Their sequential switching being determined by the sync pulse coming off the tape. With a "rotary" transformer to get the signals in and out again. And a control track to keep all of the dynamic components at their theoretically correct positions (this, and the audio track, being on opposite edges of the tape, outside the video portion). It was no wonder that the price was a cool $50,000!

This was beyond the means of the potential industrial, commercial and educational users, who would constitute a very



EQ 358

Fig. 1. Quadruplex format

much larger market. So an alternative recording system was required. One that would provide reasonable quality pictures, without needing to be of broadcast standard. A much smaller and lighter machine that could be moved around, and eventually become truly portable. One that could be sold at a competitive price.

ROTARY TWIN HEAD RECORDERS

The answer lay in a patent filed in 1953 by Eduard Schueller of Telefunken, detailing a rotary twin head recorder using helical scanning. Where a tape was wrapped in a shallow helix around a large diameter horizontal drum. Scanned by the two heads rotating inside, through a narrow slit in the wall. Each oblique track—much longer than in Quadruplex—containing all of the information necessary for a 20ms field. With again, audio and sync tracks recorded on opposite edges by separate fixed heads.

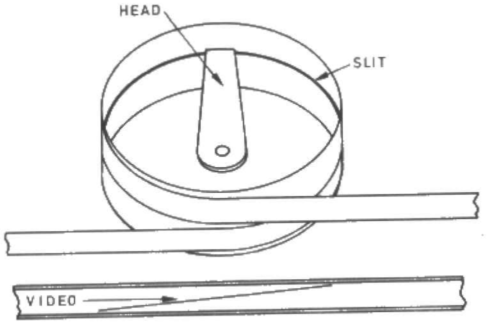


Fig. 2. Helical scan system

Actually, the early helical scan recorders tended to have just the one head, to remove the switching and matching necessary with the broadcast machines, Fig. 2. Although the effects of unmatched heads would naturally be far less noticeable in alternate fields than in 16 line "bands". This single head rotated at 50 r.p.s.; and writing speeds were typically around 25m/sec—depending on the circumference of the drum. Tape speeds varied between 12cm/sec and 25cm/sec with the 25mm or 50mm tape looped 360 degrees around the drum in what was known as the alpha wrap—because of its resemblance to the Greek letter. The first VTR to break the £1,000 price barrier, the Philips EL3400, was of this type; for the first time incorporating the now common ferrite pole tips to reduce head wear.

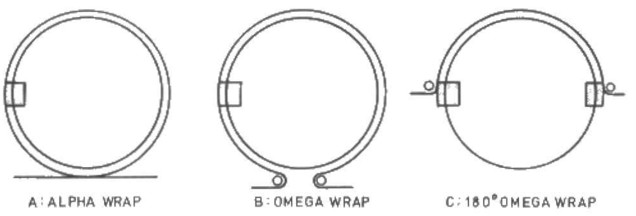


Fig. 3. Tape wrapping arrangements

For this, along with tape wear caused by contact with these rapidly scanning tips and by the tapes passage around a stationary drum, were the penalties being paid for the dramatic reductions in size and cost. Problems that were eased somewhat by an alternative wrapping arrangement: omega Fig 3b, where contact was less than 360 degrees. The few lines that were missed because of this, being of no consequence if the blank was fixed at either the top or bottom of the picture. But, although both of these arrangements are still in use today, it was the 180 degree omega wrap Fig 3c that really eased the problems. It did require two heads, which re-introduced switching—so as to avoid their both contributing noise—and the problem of their uneven wear; but these factors were becoming of less significance as both design and technology advanced.

The LVR system from Toshiba employs a continuous tape loop with the audio and video encoded together.

In the same year that Philips announced their sub-£1,000 industrial recorder—1964; Sony announced a 180 degree omega wrap helical for just £200! Not surprisingly it received a good deal of media coverage, as the first VTR to fall within the reach of the domestic user; including a demonstration on the BBC children's programme, "Blue Peter", when it appeared in Britain in '66—at almost twice the price.

It did cheat a little however; recording only every other field, playing that back twice for a properly interlaced frame. Reducing the recording bandwidth to a mere 1·5MHz. The two heads (record/playback & playback only) rotated at 25 r.p.s., as is usual with a 180 degree wrap. The 12·5mm tape ran at 19cm/sec. No RF modulator was fitted though, so playback had to be through an in-built pivoted monitor; a small one, that subjectively improved the results.

But who wanted to pay for a small screen, when they already had a large one? Or a monochrome system, when colour was obviously going to be the thing of the future? And to put up with the inconvenience of open reels, when the advantages of cassettes and cartridges were already being made available to users of audio recorders? Not too many as it turned out. Not in the domestic market, anyway; although it was quite well received by industrial and educational users (well, at under £400, it would be).

A subsequent version sprouted a couple of extra heads, to record chrominance in the guard bands between the luminance tracks. But it, and the few other skip-field helicals that appeared at intervals over the next ten years, were an evolutionary dead-end in the ascent towards a sure-fire domestic formula. Although the Matsushita-National VX2000 did achieve the distinction, in 1976, of being first to exceed 60 minutes playing time—a figure that had become something of a psychological barrier. But it was never marketed in Europe, and was really obsolete before it was ever announced.

BETA 1

For, almost exactly a year earlier, Sony had brought out their Beta 1 cassette recorder that exploited a more elegant means of making the most of a given length of tape: slant azimuth (Fig. 4.). Allowing the bands of blank tape left between the tracks—guarding against crosstalk—to be eliminated; increasing the recording density and thus reducing the tape running costs. Now, crosstalk was dealt with at the FM luminance carrier frequencies of around 4MHz by slanting the azimuth angles of the two heads by plus and minus 7 degrees; creating enough distinction between their respective tracks to achieve around −30dB attenuation. While, at the much lower frequency (686kHz) where the converted chrominance signal was located (and the effectiveness of the technique was reduced to about −10dB), attentuation was achieved by phase shifting and a comb filter. Quad machines record luminance and chrominance together, but domestic recorders and some of the other helicals separate them and record "colour under" on an AM sub-carrier.

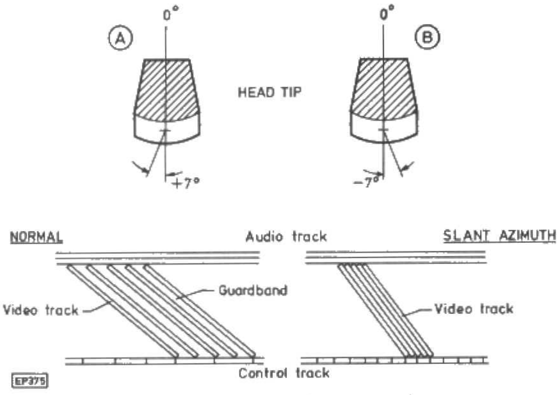


Fig. 4 Slant azimuth tape system

But, unlike the VX2000 recorder, it remained within the 60 minute time barrier; and so it was a target for the same criticisms that were being directed at the Philips N1500, introduced in 1974. Too little time for recording feature length films off-air, and for playing the pre-recorded cassettes that would be needed to bring variety to the consumers viewing and to stimulate sales. Too little time for even an hour long programme, if the recorder was activated by the integral timer and the start of the programme was delayed—as common an occurrence then, as now.

VHS

Therefore, in late '76, JVC announced their VHS (Video Home System) format; which better exploited slant azimuth by offering a maximum of two hours from a cassette. Sony, who had offered their Beta format to JVC's sister company, Matsushita, were not amused; and within a few months brought out their two hour Beta 2 format—supported by Sanyo and Toshiba. Matsushita dropped their VX2000, and went VHS. The chance for a united Japanese front had gone.

In Europe, Grundig went slant azimuth and brought out their own two hour modification to the basic Philips VCR (Video Cassette Recorder) format. Philips followed suit by announcing their own two hour long play version—VCR-LP; and launched their new N1700 recorder onto the British market at the end of 1977. Within a few months, PAL versions of VHS and Beta formats hit the British market with maximums of three and three and a quarter hours playing time respectively. Philips squeezed another half hour out of their two hour cassette with longer, thinner tape in reply. And Grundig reduced the linear tape speed of theirs to give a maximum of four hours playing time with a format they called: SVR (Super Video Recorder).

INCOMPATIBLE SYSTEMS

At the end of 1978 then, the consumer was faced with a choice of four, totally incompatible, formats; each one attempting to seduce him with unique features. Whereas, in fact, they were very similar indeed. All used helical scanning; although with different drum diameters and thus, writing speeds: from a low of 4·83m/sec VHS, to the 8·1m/sec of VCR-LP. All wrapped 12·5mm tape 180 degrees around the drums; although the means of drawing it out of the cassettes and the paths taken were different with each (Fig. 5). As were the tape speeds; in this case, Beta being the slowest with its extra narrow—30 microns—video tracks, at 1·87cm/sec and VCR-LP the fastest at 6·5cm/sec. Giving the Philips N1700 the best picture and sound quality. Although the co-axially mounted spools did cause some reliability problems, and made the cassettes rather bulky by comparison with the VHS and Beta ones—the same with the Grundig off shoot.

They all featured drop-out compensation—a one line video memory—to fill in any detail lost by dust on the tape, etc. Also, eight channel tuners; with limited forward timing, on one channel only. The Philips and Grundig recorders made do with just RF inputs and outputs, plus mic; while the Japanese machines added video and audio. Sound however, was as much the poor relation of video as in most television receivers, with average bandwidths from 80Hz to 8kHz and other figures to match.

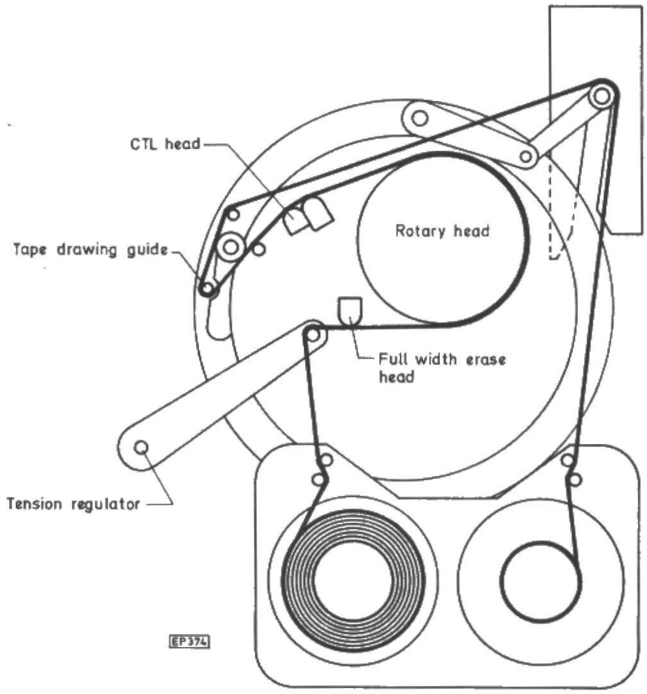


Fig. 5 Sony's U-loading

But, although video has fared rather better because of the rotating heads, its bandwidth was still limited to 3MHz; and that was only achieved by straining the technology to its limits. In fact, if the performance of magnetic tape had not improved dramatically over the past twenty years, even the advances in electronics would not have allowed home video recording to become a reality. Narrow tracks and low writing speeds, require low noise levels to achieve an acceptable picture. Techniques such as noise coring are certainly important factors, but are not substitutes for high coercivity particles. While the physical properties of the tape must combine low friction to reduce wear in the penetrating heads (they protrude through the slot in the drum), with just enough abrasivity to keep them clean. This latter degree of self-maintenence, together with the much improved binders that have largely overcome the tendency of early coatings to break up and clog heads and guides, removes the temptation for owners to attack the works with good intention. And the problems that would occur without regular maintenence.

NEW FORMATS

After the initial rush by manufacturers to get a video recorder onto the market—mostly JVC's machine with a bit of cosmetic reworking; 1979 saw two distinct trends emerging: the upgrading and diversification of the basic machines, and an injection of variety in the shape of three new formats. Having apparently decided that the facilities offered by the first crop were the least that the consumer desired; they set about building on these to make the products that much more desirable. The timer, for example; originally operative over a mere three days, now gave the user the chance to be away for a week or more without having to miss a favourite programme, or several programmes on one or more channels. And programmes could now be located automatically by identification pulses at their beginnings and ends.

Variations of fast and slow playback were other features introduced; and with them another problem; change the speed of the tape, and the angle of the head path is changed. Thus, it will deviate from the track that it's scanning, if that track has been recorded at the normal speed: following a more shallow path at high speed and a steeper one as the speed is reduced. With noise bars as the result. A compromise adopted by JVC in their HR3600 recorder, is to have one extra width head just wide enough to cover the angle change.

DYNAMIC TRACK FOLLOWING

A rather more elegant answer was forthcoming from Philips, in their new V2000 format—co-developed by Grundig. Dynamic Track Following; where the heads are made to follow the tracks by the application of a specific voltage to the piezo-ceramic plates on which they are mounted. A technique that had previously been confined to machines of broadcast quality. But even if speed variations had not been anticipated, the need for precise alignment of heads to their tracks was essential with the video tracks being as narrow as 22·6 microns. Particularly so, with the unique turn-over cassette that's been adopted; reducing the 12·5mm tape to two self-contained 6·25mm lengths (Fig. 6). Which was partly done to increase the tape speed to 2·44cm/sec (impossible otherwise with such narrow tracks) to maintain a tolerable sound quality—enhanced 8dB by a noise suppression process. And partly to increase the maximum playing time to two times four hours (useful to someone thinking of starting a programme archive).

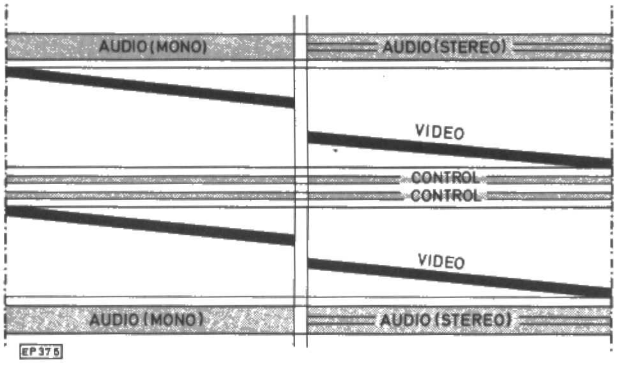


Fig. 6 V2000 format

Actual control of the video heads is acheived by their writing auxiliary signals with constant frequency (every four tracks) during recording, in the sequence: head 1 with f1=102kHz, head 2 with f2=117kHz, head 1 with f4=164kHz and head 2 with f3=149kHz, and so on, (Fig. 7). When the heads do overlap adjacent tracks during playback, the difference between the wanted auxiliary signal and the crosstalk one becomes the means to correct the deviation. The directional information—up or down, being supplied by whether the overlap results in a difference signal of high or low frequency. Should both heads deviate equally in the same direction, then the control voltage is fed to the capstan servo instead. During recording, tolerances and ageing can be compensated for by writing an additional burst of 1·5 lines duration within the vertical blanking interval at a frequency of f5=222kHz (Fig. 8). The head then switches to playback for another 1·5 lines to read the burst on the previous track at a level dependent on its distance from the latter. Measurements from both heads are then compared, and the difference provides the voltage to control one of the heads—the other being fixed. As all of these frequencies are well below the 625kHz of the chrominance carrier, no interference is caused. And the whole DTF process does away with the need for a sync track.

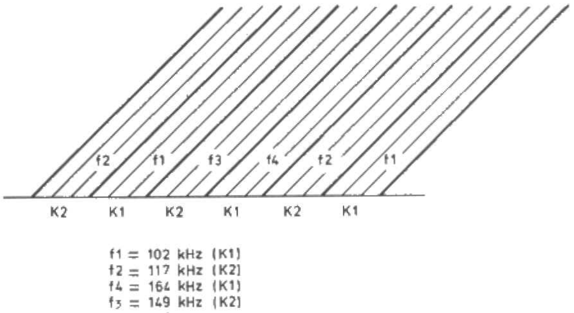


Fig. 7. Control frequencies for video heads

The first two machines—naturally from Philips and Grundig, although interest is being shown by others in their new format—are now available. Of the two, the Philips VR2020 is the more sophisticated; with more use made of the microprocessor for control and programming. Although Grundig's Video 2x4 isn't backward; and it is the first European machine to feature front loading of the cassette (Sharp were the first, with their VHS machine to the NTSC standard).

LVR's

The other two formats announced will also be held back until later this year. Both of them LVR's (longitudinal video recorders), having a fixed head laying down parallel tracks along the tapes length. But there the similarity ends. The BASF format is a bi-directional one, running 8mm tape back and forth at 4m/sec, recording 72 two and a half minute tracks, with a turn-around time of just 100ms—exactly five fields, during which the head steps down a track. A design reminiscent of several prototypes that have appeared over the years—one of them using a

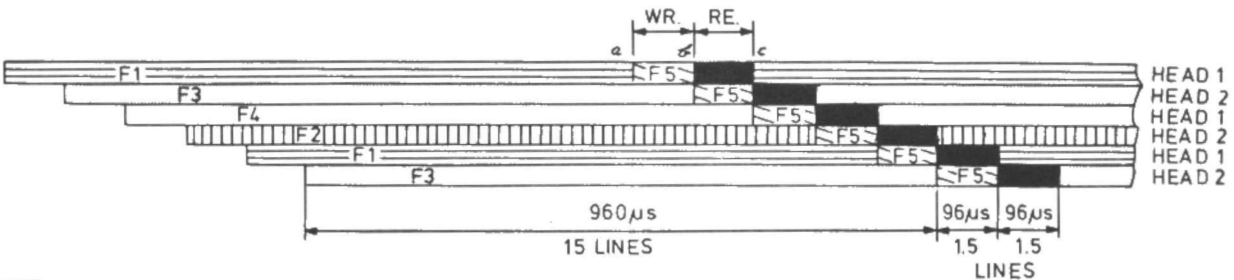


Fig. 8. Additional 1·5 lines to compensate for tolerances and ageing

modified Collaro tape deck and disappeared when the obstacles proved too great (BASF have now been working on it for over eight years). In basic layout it's very similar to the Newell bi-directional recorder that appeared in 1967—conceived as a computer data store, that kept the tape in tension by having the tape reels pressed tightly against a large capstan taking the tape past the head. Although BASF have introduced refinements such as air-guiding and automatic take-up when the feed spool is inserted (the other remains in the machine) (Fig. 9). They have also incorporated the first digital timebase corrector into a domestic machine. Which, in addition to steadying the jittery sync pulses at that velocity, also removes wow and flutter from the two audio channels; encoded in with the video on FM carriers at 100 to 200kHz. Second generation recorders may also incorporate a field store to fill in the 100ms gap, if cost can be reduced enough.

That's one problem that Toshiba's LVR won't have to face; they've gone for a continuous loop, covering the 12·5mm tape with 300 tracks of twenty four seconds duration. Also with video and audio encoded together. But whether an air cushion and back-coated lubricant can solve the friction problem of drawing tape out of a cartridge at 5·5m/sec as Toshiba claim, will only be answered when they go into production.

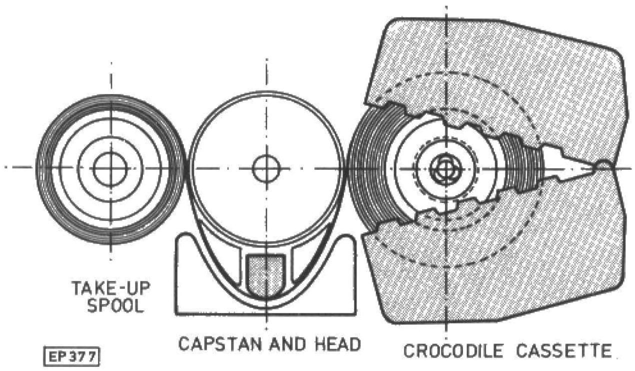


Fig. 9 BASF's LVR system

But, in one form or another, LVR's seem destined to stay. They can be made smaller and lighter than helical scan machines, with fewer moving parts. Ultimately, both companies hope to reduce the size to the point where the recorder can be integrated into a solid-state video camera. And with Kodak rumoured to be working on an LVR, one can believe them. Another advantage they possess is that, with a multi-track head, a full tape can be duplicated in just the time it takes to play one track. And such short tracks will allow very rapid access, with the head stepped to the right one.

1979 also saw the VHS and Beta formats becoming size conscious; with the result that there are now several portables on the market, with more to follow (in the larger NTSC market first). Achieving their reduced size by having optional tuner/timers and a.c. adapters (like BASF's LVR), for normal domestic use. Giving users with more creative tendencies the best of both worlds: personal productions with a colour or monochrome camera, and the recording of broadcast programmes and the playing of videograms (a rapidly growing area).

It was thought that software producers were going to wait for the video disc; but the continuing delay and the uncertainty as to which format will come out on top has forced them to press on. As the intention is to provide a playback only medium, having the one format would ensure a healthy market. But there's still a gulf between those who favour the more elegant optical approach and those who prefer the cheaper mechanical one. The former are led by Philips, whose VLP machine has already been test marketed in Georgia USA; using laser light reflected back from the encoded video and stereo audio signals etched into the disc. While the latter approach is favoured by JVC and RCA; where the disc and a stylus form the two halves of a low value capacitor, with the encoded signals producing capacitance variations. The only real difference between these being that the RCA disc has guiding groves; whereas JVC's stylus has to be centred by a servo, from tracking signals contained in a parallel spiral. The Philips laser is centred by information derived from any deviation of the reflected beam from its sensor. As it's now forty-five years since Baird's seven bob 78's were offered for sale in Selfridges, it's about time there was a replacement.

But of all the things that are likely to come in the future, the most far reaching must be the eventual changeover from analogue to digital recording. With audio coming first, and then video. Sony have already demonstrated a fiftieth generation copy to show the stability inherent in pulse code modulation. While Ampex are aiming at a super high bit rate of 1000 Mbs; using helical scanning, with each head composed of a stack of 25 or 30 thin film inductive heads. Aimed, naturally, at the broadcast user. But, like video recording itself, the principles will filter down to the bottom consumer level given time (although BASF suggest that audio quality with their LVR might make domestic digital superfluous?).

The only thing that does seem certain about the future of home video, is that the rate of new developments will continue to confuse the public for sometime to come. Confuse everyone, with all of the claims and counter claims that manufacturers throw up through their public relations and advertising, where everything is unique. Providing a continued stimulus for articles on the subject. ★

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TAPE SLIDE SYNC

DESIGNED and DESCRIBED by R.A.PENFOLD

WITH the aid of our tape/slide synchroniser you can give a professional touch to your slide shows. The unit will automatically operate the motorised slide change mechanism of a projector at the appropriate times, while a tape of background music and/or a commentary is being played. The music/commentary is carried on one channel of a stereo tape, while short bursts of audio tone are recorded onto the other channel at the points where slide changes are required.

The synchroniser really consists of two separate circuits; a tone generator which can be used to record the slide-change signals onto the tape at the same time as the music/commentary is being recorded, and an electronic switch which will operate the slide change mechanism of the projector when it receives the audio tone signals. The design described here is for an inexpensive battery operated synchroniser which should be sensitive enough to work properly with any reel to reel or cassette recorder.

CIRCUIT DESCRIPTION

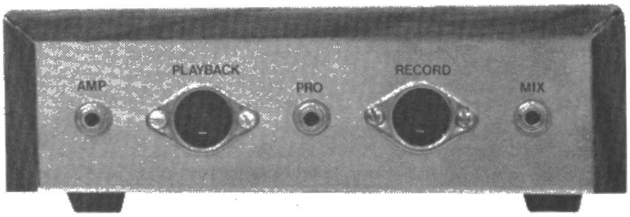
The complete circuit diagram of the Tape/Slide Synchroniser unit is shown in Fig. 1.

The tone generator, which is based on IC1, uses a well known configuration. IC1 is a 741C operational amplifier, and R3 to R5 are connected to make this operate as a type of Schmitt Trigger. If the inverting input is taken above $\frac{2}{3}$ V+, the output of IC1 goes low. Taking the inverting input below $\frac{1}{3}$ V+ causes the output of IC1 to go high.

At switch on, C5 will be uncharged and the inverting input will be at the negative supply rail voltage. IC1's output therefore goes high, and C5 charges up via R6. When the charge on C5 exceeds $\frac{2}{3}$ V+ the output of IC1 triggers to the low state, and C5 then starts to discharge through R6. This continues until the charge on C5 drops below $\frac{1}{3}$ V+, whereupon the output of IC1 returns to the high state and C5 starts to charge up by way of R6 once again. Thus the circuit continuously oscillates producing a squarewave signal at the output of IC1. The specified component values give an operating frequency of about 4kHz, but the precise frequency of the tone generator is not of great importance.

As the output of the tone generator is rather high in amplitude, being several volts peak to peak, it is connected to the left hand channel of output socket SK2 via the attenuator R7 and R8. The right hand channel of SK2 connects direct to input socket JK3, and the music or commentary signal is applied to JK3. S2 controls the negative supply to the tone generator, and is pressed to produce the required short bursts of signal. It may sometimes be more convenient to use an external switch contained in a small hand-held box, and such a remote control switch can be connected to JK4.

The left hand output from the tape recorder, which con-



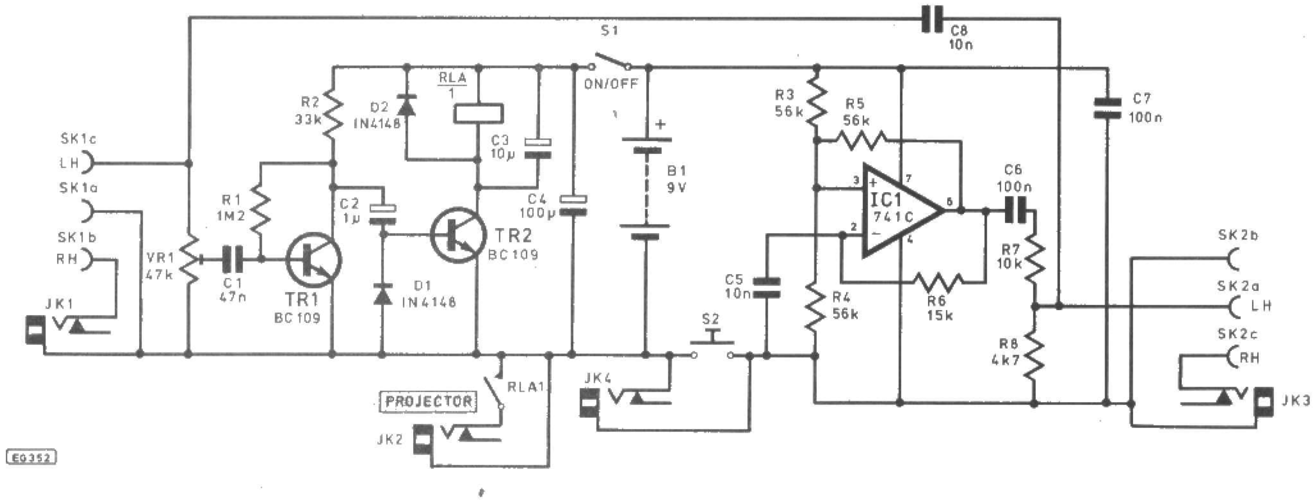


Fig. 1. Complete circuit diagram of the Tape/Slide Synchroniser

tains the tone bursts, is fed via VR1 to the high gain common emitter amplifier of TR1. The preset VR1 can be used to reduce the sensitivity of the unit if it should prove to be over-sensitive for the particular recorder being used.

The capacitor C2 couples the amplified signal at TR1's collector to the base of the second common emitter stage of TR2. This second stage has no standing base bias, and TR2 only conducts when the output signal from TR1 is positive going and more than about 0·6 volts in amplitude. During the bursts of audio tone TR2 will become conductive during positive going input half cycles to its base, and pulses of current are then supplied to its collector load; relay coil RLA/1 and capacitor C3. The capacitor C3 integrates the pulses of current to provide a continuous d.c. signal which energises the relay coil while the audio tone is present. Of course, in the absence of the tone there is only an input of background noise, and this is insufficient to activate the unit. Thus the relay is only operated during the bursts of tone, and a pair of normally open relay contacts are used to activate the slide change mechanism of the projector during each tone burst.

The diode D2 is the usual protective diode that is included across high inductive loads in semiconductor circuits. There is no danger of TR2 passing an excessive collector current into the low collector load impedance of C3 and the relay coil, since the base drive current cannot be high enough to produce such a current. D1 ensures that the input signal to TR1's base swings symmetrically either side of the negative rail, and that the unit functions correctly. S1 is the on/off switch for the tone detector circuitry.

The right hand channel input from the tape recorder is coupled direct to JK1, and from here it is taken to the amplifier. C8 couples the output from the tone generator to the input of the tone detector. This enables the projector slide change mechanism to be activated and the audio tone to be recorded merely by operating S2, and this is a helpful feature when preparing a tape. There is no need to switch out this signal path during playback, since it has a minimal shunting effect on the input of the tone detector.

The current consumption of the tone generator is only about 1mA, and the tone detector circuit consumes only about 180µA under quiescent conditions, rising to approximately 25mA during the brief periods when the relay is activated. The unit can therefore be economically powered from a small 9 volt battery.

COMPONENTS . . .

Resistors

R1	1M2
R2	33k
R3, R4, R5	56k (3 off)
R6	15k
R7	10k
R8	4k7

All resistors ⅓W 5% (10% over 1M)

Potentiometer

VR1	47k hor. preset

Capacitors

C1	47n C280
C2	1µ 25V elect
C3	10µ 25V elect
C4	100µ 10V elect
C5, C8	10n (2 off) C280
C6, C7	100n (2 off) C280

Semiconductors

D1, D2	1N4148 (2 off)
TR1, TR2	BC109 (2 off)
IC1	741C

Switches

S1	Rotary on/off switch or s.p.s.t. toggle
S2	Push to make, release to break

Miscellaneous

Relay Omron 306 ohm 12 volt coil, single changeover contact.
Sockets.
JK1, 2, 3, and 4 3·5mm jacks (4 off, see text)
SK1 and SK2 3 way DIN types (2 off, see text)
Metal instrument case about 152 × 114 × 44mm
Printed circuit board
Control knob
PP3 battery and connector to suit

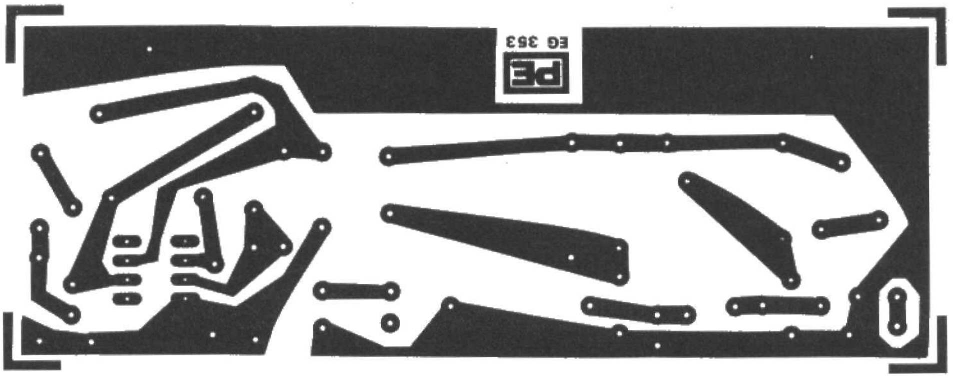


Fig. 2. P.c.b. design

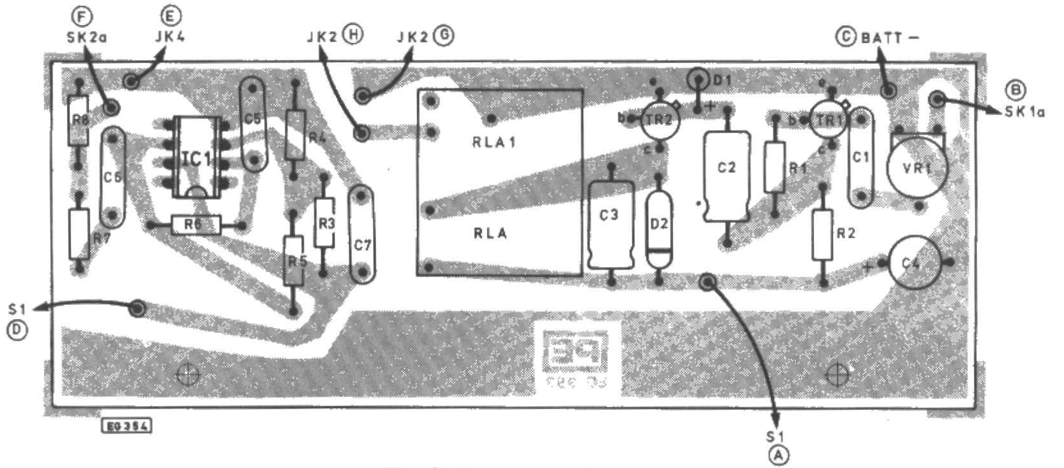


Fig. 3. Component layout

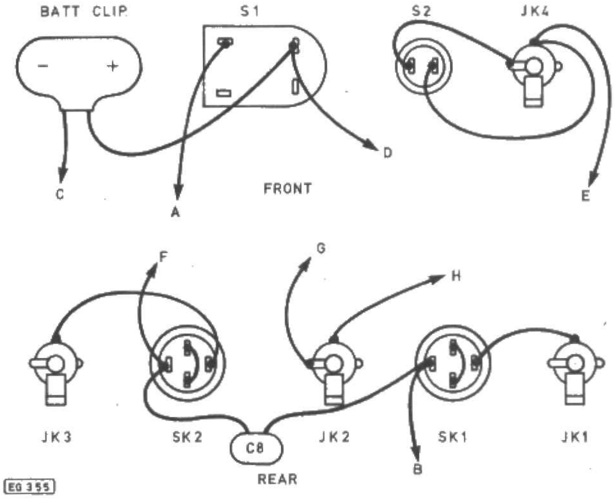


Fig. 4. Wiring diagram for the front and rear panels

CONSTRUCTION

Switches S1, S2, and JK4 are mounted on the front panel, while the other five sockets are mounted on the rear panel of the case. On the prototype 3·5mm jacks are used with 3 way DIN types being used for SK1 and SK2. However, these can be changed to types which better suit the equipment with which the unit is employed.

Except for the battery and C8, all the other components are mounted on a printed circuit board; the copper track pattern is shown in Fig. 2 with the component layout shown in Fig. 3. The specified relay is a printed circuit mounting type which fits direct onto the board, and it is therefore not advisable to use a substitute relay. However, the circuit will work with any relay having a 6/12 volt coil with a resistance of about 200 ohms or more. Make sure though, that the relay has at least one normally open contact (or a changeover contact that can be used as a normally open type) of adequate rating. The contact ratings of the specified relay are considerably more than adequate for any normal projector. A wiring diagram for the front and rear panels is given in Fig. 4.

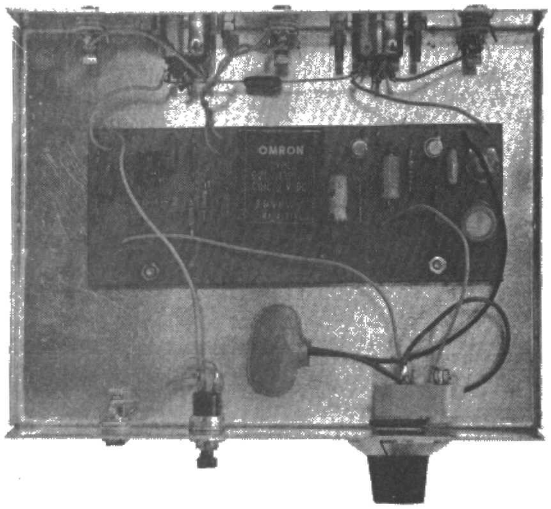
TESTING AND USE

The finished unit can be tested by switching S1 to the "on" position and pressing S2 a few times. The relay should be heard to open and close as S2 is operated, even if VR1 is well backed off (adjusted well in a clockwise direction).

In use, when preparing a tape SK2 is coupled to the input of a recorder, JK2 connects to the projector's remote control socket, and JK3 is fed with the music/commentary signal. S2 is then operated so that the recording level for the left hand channel of the recorder can be set at about 0dB. The tone detector requires a minimum input level of about 30mV r.m.s. for reliable operation, and any recorder should be capable of producing such an output signal from a 0dB recording level. Next the slide projector is set up with the first slide ready for projection, preparations are made so that the music/commentary is ready to be recorded, and then recording commences. After the music/commentary for the first slide has been recorded, S2 is operated so as to change to the next slide and record the synchronisation tone. This process is continued until the final slide is reached, and the recording is stopped when the final piece of music/commentary has been completed.

If the tape is now rewound to the beginning, SK1 is coupled to the output of the tape recorder, and the amplifier is fed with the output from JK1, the projector should automatically change the slides at the appropriate times. R1 should be set for maximum sensitivity, and will only need to be backed off somewhat if the background noise from the recorder causes the unit to operate continuously.

The unit can be used with a mono recorder as a sort of programmed slide timer. In this case the tone generator is used to record short bursts of tone to give slide changes at the required intervals during playback into the tone detector, and there is no recorded commentary or music. ★



Internal view of the Tape/Slide Synchroniser

Countdown

Microsoftware (symposium) July 7–10. University of Sussex. **S1**

Automation Exhibition July 8–10, 1980. Gloucester City College of Technology. Three half-day seminars to run concurrently: uP applications and interfacing, modern welding and CAD are the topics. Organised by the Low Cost Automation Centre of the college.

The 1980 Microcomputer Show July 10–12. Royal Lancaster Hotel, London. **O**

London Computer Fair July 11–12. Polytechnic of North London Theatre. Organised by the North London Hobby Computer Club, this is the first exhibition of its kind, including retail exhibitors, hobbyists, club stands, seminars, workshops, surgeries, a bazaar and jumble sale. This event should be great fun for the amateur and commercial computerist, as well as the casual onlooker.

BAEC Amateur Electronics Exhibition July 12–19. The Esplanade Shelter, Penarth, near Cardiff, S. Glam. Open evenings from 7pm, and weekend afternoons. **B**

Computer Graphics (exhibition & conference) Aug. 12–14. Metropole, Birmingham. **O**

Harrogate International Festival of Sound Aug. 16–19 (18 & 19 trade). The Exhibition Centre + hotels. **X**

Edtech Aug. 19–21. Holland Park School, London. **C1**

Personal Computer World Show Sept. 4–6. Cunard Hotel, Hammersmith, London. **M**

Laboratory Sept. 9–11. Grosvenor Ho., Park Lane, London. **E**

Intron 80 Sept. 9–11. RDS, Simmonscourt Pavilion, Dublin. **V**

West of England Electronics Exhibition Sept. 9–11. Bristol Exhibition Centre. **Q**

Electrathon (Lucas battery vehicle race) Sept. 13, 1980. Fashioned on last year's event, this "whispering Grand Prix" is a contest for *home made* electric vehicles. It will again be held at Donington Park Race Circuit, nr. Derby. Details: ☎ 021-554 5252.

Avionics (symposium) Sept. University of Surrey. **S1**

Emix (Electronic Measuring Instruments Exhibition) Sept. 30, Oct. 1–2. Post House Hotel, Southampton. **I**

BEX (Business Equipment Exhibition) Oct. 1–2. The Guildhall, Plymouth. **K**

Emix Oct. 7–8. Centre Hotel, Newcastle. **I**

Emix Oct. 14–15. Guildhall, Cambridge. **I**

Drive Electric October 14–17. Wembley Conf. Centre, London. Organiser: ☎ 01-834 2333.

BEX Oct. 15–16. Assembly Rooms, Edinburgh. **K**

Engineering Ireland Oct. 15–18. Leopardstown Exhibition Centre. **V**

Testmex (exhibition and conference) Oct. 28–30. Wembley Conference Centre. **T**

Viewdata Exhibition for Professional & Business People Oct. 29–31. West Centre Hotel, London. **Z1**

Compec Nov. 4–6. Olympia. **Z1**

BEX Nov. 5–6. Sophia Gardens, Cardiff. **K**

Semiconductor International 80 Nov. 25–27. Metropole Convention Centre. **T1**

Breadboard Nov. 26–30. Royal Horticultural Halls, Westminster. **T**

Microsystems 81 March 11–13. Wembley Conf. Centre, London. **L**

Inspex 1981 March 16–20. NEC Birmingham. **Z1**

Computer Graphics 1981 April 28–30. The Barbican Centre, London. **O**

Entertainment 81 May 9–17. "Audio, Video and Television Fair". NEC, Birmingham. Weekday mornings are trade only. **B2**

Components 81 (Electronic Components Industry Fair) June 9–12, 1981. Earls Court, London. This show will alternate yearly with *Electronics*, now the IEA amalgamation with Electrex has ceased. **I**

International Business Show 1981 October 20–29. NEC Birmingham. **A2**

Electronics 82 (formerly IEA, but now sub-titled International Electronics, Control and Instruments Exhibition) May 24–28, 1982. NEC. This show will alternate yearly with *Components* now that the IEA/Electrex amalgamation has ceased. **I**

B	British Amateur Electronics Club, 26 Forrest Road, Penarth, S. Glamorgan.
E	Evan Steadman. ☎ 0799 22612
ITF	☎ 021-705 6707
K	Douglas Temple Studios, 1046 Old Christchurch Rd., Bournemouth.
L	Iliffe Promotions. ☎ 01-261 8437
M	Montbuild. ☎ 01-486 1951
O	Online Conferences. ☎ 0895 39262
Q	Exhibitions For Industry Ltd. ☎ 08833-4371
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V	SDL Exhibitions, 68 Fitzwilliam Square, Dublin, Ireland.
X	Exhibition & Conference Services, Claremont Ho., Victoria Ave., Harrogate, Yorks. ☎ 0423 62677
C1	Stereoscopic Television Ltd., 41/43 Charlbert St., St. John's Wood, London NW8 6JN. ☎ 01-722 4139
S1	Society of Electronic & Radio Technicians, 57-61 Newington Causeway, London SE1 6BL. ☎ 01-403 2351
T1	Kiver Communications U.K., Millbank House, 171/185 Ewell Road, Surbiton, Surrey KT6 6AX.
Z1	IPC Exhibitions Ltd., 40 Bowling Green Lane, London EC1R 0NE. ☎ 01-837 3636
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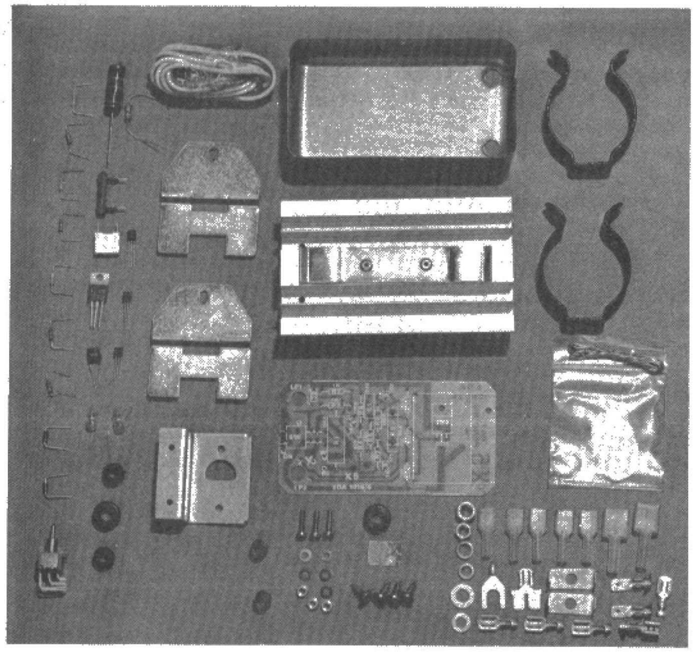


Sparkrite X5 REVIEW

THE Sparkrite X5 ignition supplied by EDA is of the inductive discharge type which greatly reduces current through the contact breaker points, extends the dwell time and eliminates problems caused by contact bounce, thus giving longer point life and an improved spark at high revs. It is not our purpose to analyse the performance of electronic ignition systems in this review. Much has been published in the motoring press and such magazines as *Motoring Which* on the merits of these systems. We do however believe that electronic ignition systems can play an important part in helping to keep the engine in tune and running efficiently and this is very beneficial when trying to obtain the best and most economical performance.

THE KIT

The Sparkrite system is obviously a professional product—the basic kit comes in a formed polystyrene package complete with all parts, including wire, solder, silicon grease for transistor mounting and even a windscreen sticker for the car. Before commencing construction we read through the instructions and checked off all parts against the components list. This operation is greatly simplified by the very clear listing of all parts, even the complete newcomer to electronics should encounter no problems as resistor, capacitor and Zener colour code and markings are provided for easy identification.

The instructions are an example to all kit compilers, they include a straightforward section on soldering for the beginner, including diagrams; an explanation of resistor colour code (in addition to the references in the components list) an excellent and well illustrated section on assembly and five pages on fitting the unit to different vehicles. Finally the instructions give a circuit diagram and an excellent and detailed description of the theory and operation of the circuit.

CONSTRUCTION

Having carefully read the instructions we had every confidence that the kit would be straightforward to assemble and this confidence turned out to be fully justified. The only area where a novice might find difficulty is the assembly of the insulation and mountings for TR4 and its bracket, this assembly is however well covered by a simple line drawing in the instructions.

All the parts fitted without any problems and there was just enough solder, the only extra item necessary was some varnish which the instructions suggest should be used on both sides of the p.c.b. before final assembly. In our view this could cause problems if it is later found that a part has been incorrectly fitted, as the varnish would prevent easy removal and refitting, this could happen even though the instructions advise a construction check before varnishing. We suggest it may be prudent to test the unit before varnishing the board.

Assembly of the kit including fitting the correct terminals took slightly less than two hours. Fitting took about 10 minutes and the unit worked first time.

FITTING

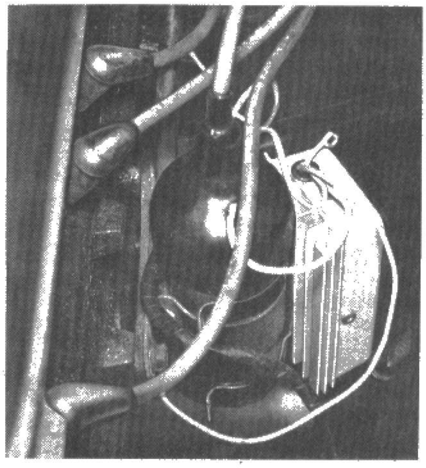
On most cars fitting is greatly simplified by the clips provided which allow the unit to be clipped to the ignition coil. It is then a simple matter—having selected and fitted the correct connections from a good range supplied—to connect up the unit and try it out.

On some cars it may not be possible to mount the ignition system on the coil, and with this in mind, EDA have supplied adaptor plates which enable the unit to be screwed to any flat surface. The connecting wires provided should be long enough to cover all situations.

CIRCUIT

The circuitry makes use of a high voltage Darlington transistor which switches the coil current. Additional facilities provided are a conventional/off/electronic switch and a lamp in series with the contact breaker which is used for static ignition timing. The unit should work with all types of tachometer and details for connecting to cars with tachometers are included.

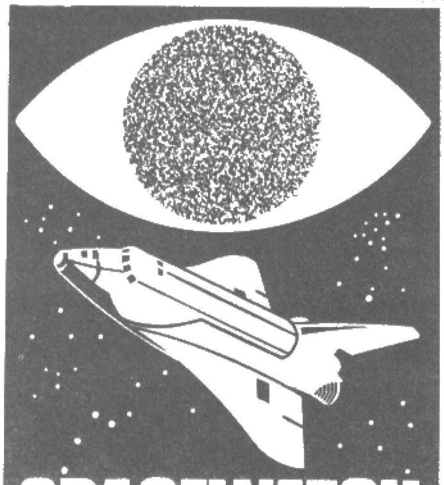
EDA operate a technical and after sales department that will help with any problems. They will also repair any kits that do not work—no charge is made if this is due to a faulty component but a nominal charge may be made if parts are damaged or incorrectly assembled.



The assembled unit clips neatly onto the coil.

PRICE

The Sparkrite X5 is available for negative earth vehicles only from Electronics Design Association, Dept. PE, 82 Bath Street, Walsall, WS1 3DE, phone (0922) 614791 for £16.95 including VAT, postage etc. Last, but by no means least all components are guaranteed for two years from date of purchase.



SPACEWATCH

FRANK W. HYDE

MARS AND ITS MOONS

The name of Laplace has been linked with the possible solution of the problem of the origin of Phobos and Deimos the Moons of Mars. A French team have suggested that the Laplace equations can offer an explanation of the capture orbits which would lead to the present near circular orbits. The fact that the present orbits are nearly circular and closely aligned with the equator, is the normal outcome of satellites formed at the same time as the parent body and not of capture. It would be unusual for them to be captured asteroids, for example, because they would be in elliptical orbits and at random angles. It is therefore difficult to accept capture in the time scale as now understood.

In Toulouse at the Centre National d'Etudes Spaciales three people, Anny Casenove, Anthony Dobravolskis and Bernard Largo have worked the evolutionary orbits again, but this time going backwards to the origin of the parent body. Examination of the orbital behaviour of the satellites in relation to Mars in its orbiting round the Sun has persuaded them that the Laplacean equations can provide the answer. The orbital plane depends on the average distance between the parent body and the satellite. This is affected by the tidal forces between them and results in the satellite orbit becoming more circular as it draws nearer to the parent.

As the satellites exist today the orbits are determined by the planets and the Laplace orbit lies near the equatorial plane. This is the observed situation. Looking back in time there comes a point when the satellites are more than 14 Martian radii from the planet. When that situation arises, the Sun's influence becomes important. The results of the calculations made by the team indicate it could have been possible for capture to have taken place when the orbits were close to the orbital plane of the Solar System. If this is so then a major objection to the capture theory has been disposed. It also provides a good support for the interpretation of the Viking pictures.

WORLD SPACE ACTIVITIES

In the last issue of *Spacewatch* a first look was given at this aspect of space endeavours. The USSR have already begun their programme with the new long term space mission with two cosmonauts one of whom is undertaking such a mission for the first time, indeed it is his first entry into space. There is the known intention of Russia to use 'add-on' method of setting up a space station and platform. This mission is the spearhead of a new series.

In the near future it would seem that emphasis will be partly on syhcronous orbital satellites for communications development. This will cover both military and civilian activities. Partly, this can be seen to be an effort to 'catch up' with the free world. Generally they are three to five years behind in this area. The USSR flew four new missions during 1979. As far as is known the programme is as follows.

Raduga Domestic Television and Telephone Relay

This is also given the designation of Stationar. Raduga numbers 1, 2 and 5 have been put into parking orbits at 80 deg East L. under the designation Stationar 1, Raduga numbers 3 and 4 have been parked at 35 deg East L. which is a Stationar 2 place. Radugas could have a capability to perform the required military communications relay. The fifth of these spacecraft was launched in April '79.

Ekran Domestic Television Relay

This is also designated Stationar 1. Four of this type have already been launched to a 99deg. East L. parking place, Ekran 3 on February 21st 1979 and continued till all four were launched by the 4th of October 1979.

Gorozot Television Relay

This was positioned mainly for the 1980 Olympics. Two spacecraft have been launched into an assigned parking place at 13·5deg West Longtitude. The first of these failed to achieve geostationary orbit. A replacement was launched on July 5th 1979. This spacecraft has a Stationar designation 4. Gorozot 3 at 58deg. East L. is at a Stationar 5 reserved area. It is expected that these will be re-positioned after the Olympics.

Louch International Communications

There are 8 spacecraft to be put in position around the Earth. They are designed to compete with the Intelsat 5 system. The first launch is expected in 1981. These craft will have an up-link frequency of 14GHz and a down link of 11GHz.

Gals Military Communications

This project has been delayed. They operate in the 8·7 GHz band at 25deg West L., 45deg. East L., 85deg East L., and 170deg West L. The function of these craft is to serve the same purpose as the United States Defence Satellite Communication System.

Volna Mobile Communications

Seven spacecraft round the Earth are planned to offer similar facilities as Marisat and Aerosat in the free world. This project, a major one, has been delayed. It was scheduled for 1980.

Two important new areas of the USSR programmes are the Earth Resources and Ocean Surveillance Resources Monitoring. On the Military side Russia has already launched Cosmos 1,094 and 1,096. These craft went into identical orbits inclined at 65deg. Until then, these spacecraft had been launched singly. The most recent mission was that one spacecraft trailed the other with a daily overlapping coverage. They were nuclear powered and since the loss of one by premature entry over Canada, no more have been launched. Using two craft together enhances the ability to track moving shipping, a technique also used by America.

THE JAPANESE PICTURE

The Japanese programme so far has given them the experience of 19 satellite launches and some 300 sounding and observation rockets. They expect to operate on a much larger scale in the 1980s. A maritime observation satellite will be launched using the three axis control. This will be a first time for the Japanese. The vehicle is expected to be launched in 1984

While the Space Agency will continue to enter into contracts with RCA and Messerschmit-Boelkow-Blohm companies it is intended that Japanese technology will be extended. They also propose to reduce their dependence on the USA for launchings. The intention is to provide their own facilities. Three launch vehicles are being developed. The first of these will become operational in 1981. This will be known as N-2. The second will be named M-3S-kai-1 and a third one designated H-1 which will be ready in the mid 1980s. The present launchers will be improved. In February 1980 NASDA launched an ECS-b. Its weight was 560lb. This was for experimental communications in the millimeter waveband. Two operational satellites will be launched in 1982 and 1983 into geostationary orbits at 135deg East Longitude These two satellites are being developed by the Mitsubishi Electric/Ford group. The Nihon Electric/Hughes group will develop a satellite to be placed in orbit which will be geostationary at 140deg East Longitude in midsummer 1981. NASDA is initiating the development of a maritime satellite for geodetic survey in 1983 with the eighth and last N-1 launcher. This is being developed by Mitsubishi Heavy Industries/Kawass-ki-Canon Camera.

A maritime satellite MOS-1 will be the first of the 3-axis stabilised vehicles. It will weigh 1,650lb. and will go into a solar synchronous orbit in 1984.

The Japanese ministry are seeking a paddle equipped three-axis vehicle in 1986 under NASDA sponsorship. A large programme is being studied and will include astronomical and X-ray observations of galaxies and nebulae. The orbital configurations will be 217 × 373 miles and 186 × 621 miles.

Tokyo University has a plan for an ambitious project for the study of Halley's Comet and Venus. The Space agency has plans for the participation of Japanese astronauts in the shuttle programme. Much activity is expected in the development of higher thrust motors and strap-on boosters.

PE DMM

MARTIN KENT

THE *PE* DMM is a 3½ digit handheld multimeter with liquid crystal display which has been designed to provide professional performance at very low cost. A multimeter is probably the most frequently used item of test equipment in any workshop and a digital multimeter can offer greater accuracy and reliability than moving-pointer types.

The heart of the instrument is the Intersil ICL 7106 which is an LSI circuit containing a complete single range voltmeter, thereby minimising the amount of circuitry required to build a multimeter. Fifteen measurement ranges are provided and the specifications listed make this an extremely versatile workmate. Use of an LCD display gives large, easily read digits and a very long battery life.

MULTIMETER BASICS

Digital displays are superior to mechanical types in that they are mechanically much more robust whilst providing increased resolution of reading and higher potential accuracy. A 3½ digit display has a full scale reading of 1999 and a possible resolution up to one part in two thousand, or 0·05%. Liquid crystal displays are becoming well known for their microamp current consumption and high visual contrast even in direct sunlight. Laser sealing techniques used in LCD manufacture result in an operating life in excess of fifty-thousand hours.

Numerous techniques are available for conversion of analogue information to digital data but the most commonly used is dual-slope integration. The block diagram of a dual-slope analogue-to-digital convertor is shown in Fig. 1.

The input voltage is applied to the integrator and the counter starts to count clock pulses. After a prescribed number of counts, time interval T, a reference voltage of opposite polarity is applied to the integrator. The accumulated charge on the integrating capacitor at this instant will be proportional to the average value of the input voltage over the interval T. The counter again starts counting from zero and the integral of the reference is a negative going slope with gradient of V_{ref}/RC. When the integrator output reaches zero, the counter is stopped and its output will be proportional to the input voltage. By choosing the value of V_{ref} accordingly, the full scale count can be set to a convenient number. In the case of the ICL 7106, full scale of two thousand counts is achieved when $V_{in} = 2 \times V_{ref}$ and a 100mV reference voltage is normally used. For inputs exceeding full scale, the 7106 is designed to display a 1 in the most significant digit with following digits suppressed.

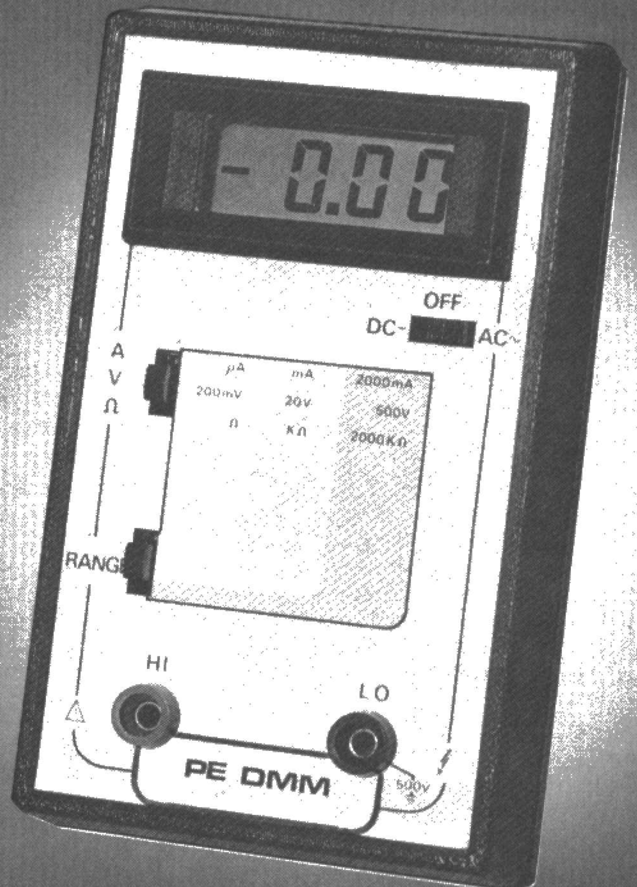
Conversion accuracy of a dual-slop a/d convertor is independent of component values and clock frequency and is primarily dependent on reference voltage stability.

CIRCUIT DESCRIPTION

The complete circuit diagram of the *PE* DMM is shown in Fig. 2.

IC1 is the 7106 integrated circuit which forms a 200mV f.s.d. voltmeter. The input impedance of the a/d convertor is greater than 100 megohms to ensure that negligible current is drawn from the circuit being measured, providing optimum accuracy. An input filter to limit input noise voltages is formed by C5 and R18, the latter also assists with overload protection of IC1 by restricting the input current under gross overload conditions.

An on-chip reference voltage is provided at pin 32 of IC1 which is maintained at approximately 2·8 volts below the positive supply rail. The reference voltage is a critical part of any a/d convertor since all inputs are compared against the reference. To optimise voltage reference stability, a bandgap voltage reference device, IC4, is used which operates from the on-chip 2·8 volt reference. The reference voltage output



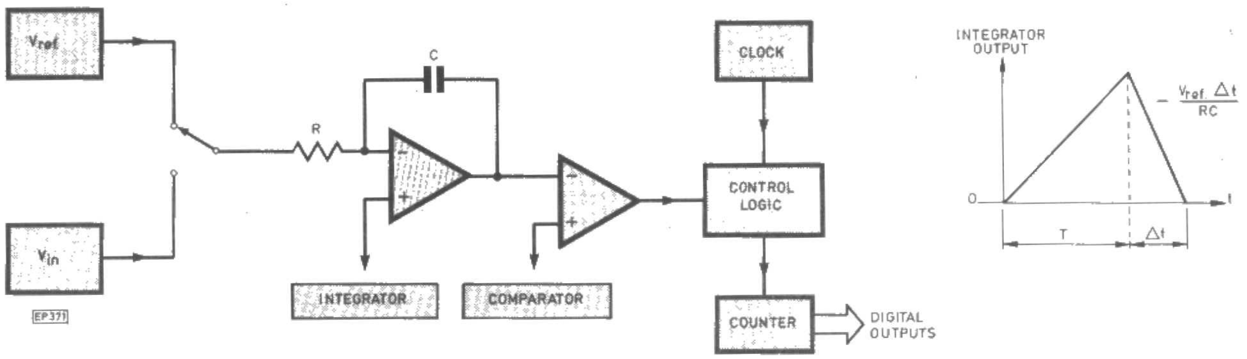


Fig. 1. Block diagram of a dual slope a/d convertor

of bandgap devices depends inherently on the properties of transistor junction potentials. The V_{be} of a junction depends upon bulk properties and doping levels of the semiconductor material, its long term stability is essentially unaffected by surface phenomena. A potential divider is formed by resistors R19, R22, R23 and VR1 to adjust the output of IC4 to produce an extremely stable 100mV reference, while C6 eliminates any noise voltages.

The frequency of the interval clock oscillator is controlled by C10 and R25, the values chosen provide a frequency of approximately 48 kHz to produce a conversion rate of three readings per second with good rejection from 50Hz pick-up.

The a/d convertor is inherently auto-zero in its operation, such that when the inputs are shorted together the digital outputs are guaranteed to be zero, to eliminate the need for offset adjustments. The auto-zero capacitor C8 prevents noise voltages affecting the above function. The integrator time constant is set by C7 and R24.

DISPLAY REQUIREMENTS

The 7106 drives liquid crystal displays direct and the square wave backplane signal is provided at pin 21. LCDs require a.c. drive signals since steady d.c. potentials can burn-in the segments. For a particular segment to be turned on, it must be driven by a signal of equal amplitude but opposite phase to the backplane signal.

Voltage comparator integrated circuits are designed to produce a logic 1 output when the difference between the inputs is positive and a logic 0 when the difference is negative. This is the basis of the auto-polarity circuitry within IC1 which drives the negative polarity bar directly from pin 20. Decimal points are selected by a section of the range switch S3b and the correct LCD drive is provided by two dual-input Exclusive-OR gates within IC5. Examination of the truth table of an Exclusive-OR gate will show that the output is high if one or other of the inputs is high, but the output is low if both inputs are high. If one of the inputs is used as a control input, when it is low it will allow through the gate a high or low level as applied to the second input. When the control input is high it will invert the level applied to the second input. Resistors R30 and R29 hold the control inputs, pins 6 and 1, of IC5 at a normally low level by using the test output, pin 37, of IC1. The backplane signal is applied to IC5 pins 5 and 2. When either R30 or R29 is taken to a high level by S3b, the respective gate acts as an invertor to provide an output in antiphase to the backplane input and so provide the required LCD drive signal.

When using battery-operated instruments, it is important to know when the battery voltage is dropping to a level where performance of the instrument may be impaired. The liquid crystal displays which are supplied in the kit of parts available from Lascar Electronics incorporate "LO BAT" wording which can be turned on when the battery voltage has dropped such that 20% of useful life remains. The operator therefore receives advance warning of battery failure while being able to maintain accurate readings until the battery can be changed.

A potential divider is formed across the supply rails by R26 and R27. When the supply voltage drops to approximately 7 volts, TR1 collector is taken low, making IC5d pin 10 high. IC5c becomes an invertor for the backplane signal and turns on the low battey warning display segments.

INPUT CONDITIONING

The multimeter will accept a wide range of a.c./d.c. voltage and current inputs together with resistance measurement but all input levels require conversion to a voltage in the range 0-200mV d.c. in order to make them compatible with the a/d convertor.

Comprehensive overload protection is incorporated on all measurement ranges up to at least mains voltage to minimise any possibility of damage which may otherwise be caused by inadvertently selecting the wrong range.

Now let us consider how the single range voltmeter is made into a multimeter.

SPECIFICATION

Function	**F.s.d.**	**Resolution**	**Accuracy**	**Protection**
Volts (d.c.)	200mV	0·1mV	0·5%± 1 digit	±500V d.c. for one minute
	20V	10mV	,,	
	500V	1V	,,	
Current (d.c.)	200μA	0·1μA	0·5%± 1 digit	2A/250V
	20mA	10μA	0·5%±1 digit	
	2000mA	1mA	2%±1 digit	
Volts (a.c.)	200mV	0·1mV	1·25%±5 digits	500V a.c. for one minute
	20V	10mV	,,	
	500V	1V	,,	
Current (a.c.)	200μA	0·1μA	1·75%±5 digits	2A/250V
	20mA	10μA	1·75%±5 digits	
	2000mA	1mA	3%±5 digits	
Resistance	200Ω	0·1Ω	0·75%±3 digits	300V d.c./a.c. r.m.s.
	20kΩ	10Ω	0·75%±3 digits	
	2MΩ	1kΩ	0·75%±3 digits	

Input impedance	10MΩ
Max. common mode voltage	500V d.c.
Battery type	PP3, approximately 200hrs operating life.
Case size	Length 145mm, width 92mm, height 29mm.

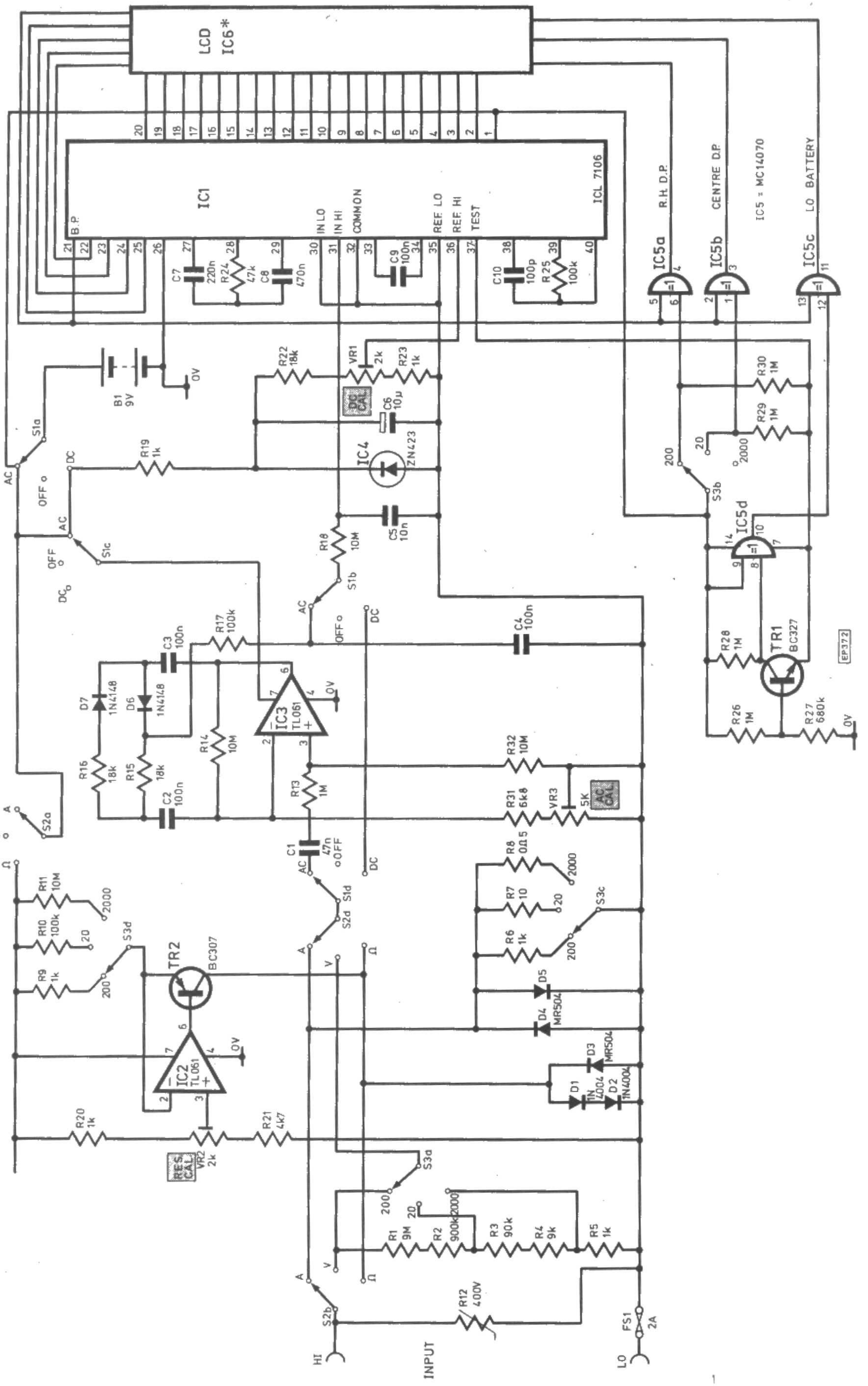


Fig. 2. Circuit of DMM

DC VOLTAGE AND CURRENT RANGES

Switch S1 selects d.c. or a.c. functions whilst connecting the battery supply to the appropriate sections of circuitry via S1a and S1c. With the switch in the centre "Off" position, S1b and S1d isolate the input of the a/d convertor to prevent damage. Once the d.c. functions are selected, S2b and S2d route the input to either current, voltage or resistance measurement stages. For the 200mV d.c. range the input is connected straight to the 200mV f.s.d. a/d convertor but the 20V and 500V ranges are passed through an attenuator formed by R1-R5. The attenuator resistors are extremely stable 0·25% metal film types and the input resistance of the instrument on voltage ranges is set at the standard value for DVMs of 10 megohms.

Voltage dependent resistor R12 is connected across the input terminals to clamp any transient high voltage spikes which may otherwise cause damage to the instrument. The VDR normally exhibits extremely high resistance such that it does not affect measurement accuracy but when the threshold voltage is exceeded, the device alters rapidly to a low resistance to shunt out transients. With S2 switched to current measurement, S3c switches into circuit one of three shunt resistors, R6-R8, which are 0·5% metal film types. A 2A fuse connected in the common line protects against excessive input currents whilst diodes D4 and D5 protect the instrument from the application of high input voltages, including mains supply.

AC VOLTAGE AND CURRENT RANGES

When S1 selects a.c. functions, capacitor C1 is connected in series with the input to remove any d.c. component present. Voltage inputs are fed through the input attenuator as before and current inputs are fed through the shunt resistors.

IC3 is a TLO61 operational amplifier connected as a precision rectifier. Alternating inputs are rectified by diodes D6 and D7 with the positive component sampled by R14 then filtered by R17 and C4. The op-amp has a j.f.e.t. input resulting in high input impedance and the supply current consumption is only 250µA which makes it ideal for battery operation. The circuit is mean sensing and calibrated to indicate the r.m.s. value of sine wave inputs by adjustment of VR3.

RESISTANCE RANGES

For resistance measurement, a constant-current generator is used with currents selected to develop up to 200mV across the unknown resistance.

A TLO61 j.f.e.t. op-amp is used as a buffered reference source, the output voltage of which is set by the potential divider R20, R21 and adjusted by VR2. S3d selects range resistors R9, R10 and R11 which set constant currents of 1mA, 10µA and 100pA respectively through the collector of TR2. Open-circuit voltage is 1 volt which will place the display into overrange condition, indicating infinite resistance in the absence of an external resistor.

COMPONENTS

Resistors

R1	9M	Metal film	0·25%
R2	900k	"	0·25%
R3	90k	"	0·25%
R4	9k	"	0·25%
R5	1k	"	0·25%
R6	1k	"	0·5%
R7	10	"	0·5%
R8	0·5	wire wound	5%
R9	1k	metal film	0·5%
R10	100k	"	0·5%
R11	10M	"	0·5%
R12	400V	VDR	
R13	1M	carbon film	5%
R14	10M	"	5%
R15	18k	"	5%
R16	18k	"	5%
R17	100k	"	5%
R18	10M	"	5%
R19	1k	"	5%
R20	1k	"	5%
R21	4k7	"	5%
R22	18k	"	5%
R23	1k	"	5%
R24	47k	"	5%
R25	100k	"	5%
R26	1M	"	5%
R27	680k	"	5%
R28	1M	"	5%
R29	1M	"	5%
R30	1M	"	5%
R31	6k8	"	5%
R32	10M	"	5%

Switches

S1	4 pole 3 way switches
S2	"
S3	"

Capacitors

C1	47n	polyester	250V a.c.
C2	100n	"	100V
C3	100n	"	100V
C4	100n	"	100V
C5	10n	"	400V
C6	10µ	tantalum bead	16V
C7	220n	polyester	100V
C8	470n	"	100V
C9	100n	"	100V
C10	100p	polystyrene	

Semiconductors

D1	1N4004	
D2	1N4004	
D3	MR504	
D4	MR504	
D5	MR504	
D6	1N4148	
D7	1N4148	
TR1	BC237	
TR2	BC307	
IC1	ICL7106	
IC2	TLO61CP	
IC3	TLO61CP	
IC4	ZN423	
IC5	MC14070BCP	
IC6	3½ digit LCD display	587-298 R.S.

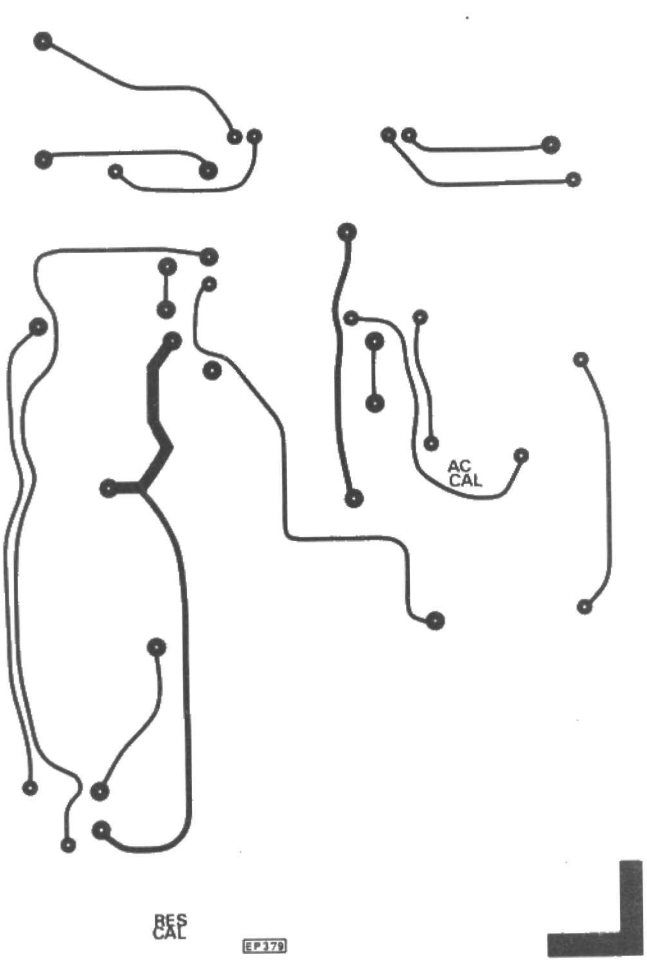
Miscellaneous

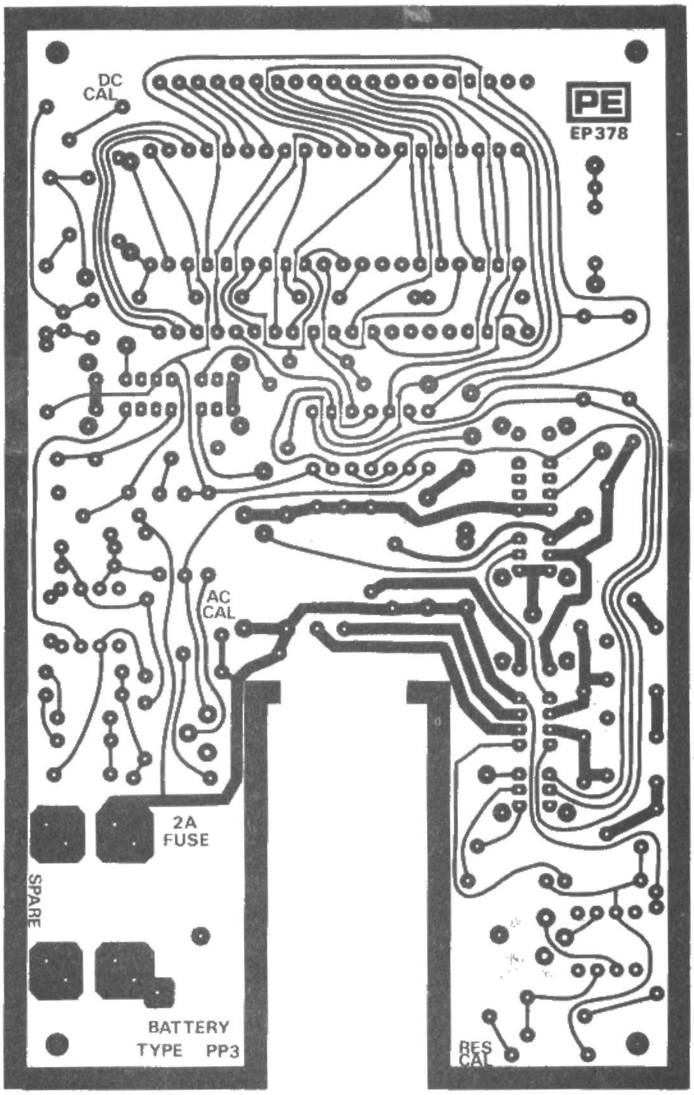
2 sets of 20 way soldercon pins, 4 p.c.b. 20mm fuse clips, FS1-2A, through board pins—10 off, PP3 and battery connector, p.c.b. 4mm terminals, 4 spire clips.

Note: A complete kit of parts for the *PE* DMM is available from **Lascar Electronics Ltd., Unit 1, Thomasin Road, Burnt Mills, Basildon, Essex, SS13 1LH,** price £39.04 which includes p&p and VAT. A calibration service is available for an inclusive charge of £5·60. Calibration and fault finding is £8·50 plus parts. (Tel: Basildon (0268) 727383)

Fig. 3. (below) Topside of p.c.b

Fig. 4. (right) Underside of p.c.b





Diodes D1-D3 protect the resistance measurement circuitry from the application of high input voltages which may arise when inadvertently working on live equipment. The diodes will shunt the input voltage and cause the fuse to blow if an input current of 2A is reached. In general, equipment under test should be switched off when checking resistances.

CONSTRUCTION

The use of an LSI a/d convertor greatly reduces component count and when combined with a double-sided printed circuit board the construction of such a comprehensive instrument becomes relatively straightforward.

The high cost of plated through hole connections is avoided by using pins designed for through board connection, or alternatively copper wire could be used. Solder-resist coated boards are supplied in the kit of parts available from Lascar Electronics. The coating eases the soldering of small connections which may be grouped close together, such as integrated circuit pins, although soldering should only be attempted with a fine-tipped iron. Circuit stability is also improved as the coating helps to exclude moisture from the glass-fibre board. There are ten through-board pins which should be soldered in place before components are mounted onto the board.

Printed circuit board patterns for the upper and lower surfaces are shown in Figs. 3 and 4 respectively whilst the component layout is shown in Fig. 5. The pads shown in Fig. 3 are top surface solder joints which should all be soldered to complete circuit continuity. Due to the access required for top surface solder joints, the integrated circuits and transistors should be fitted first noting the orientation on the board. IC1 and IC5 are MOS construction and although the types specified are protected from static discharge they should be handled carefully and soldered in place without use of excessive heat.

The three slider switches should now be fitted and checked to ensure that they are sitting perpendicular to the board to ensure alignment of the toggles with the front panel cutouts.

Chassis mounting clips for the 20mm fuse may now be fitted to the underside of the board together with a pair for the spare fuse position if required.

The resistors should then be fitted, noting the difference between the critical range-setting metal-film resistors and the non-critical carbon-film resistors. The variable calibration resistors should be fitted, followed by the capacitors and diodes.

Two strips of soldercon pins are used as sockets for the liquid crystal display and should now be soldered in place, followed by the two input leads and the battery connector.

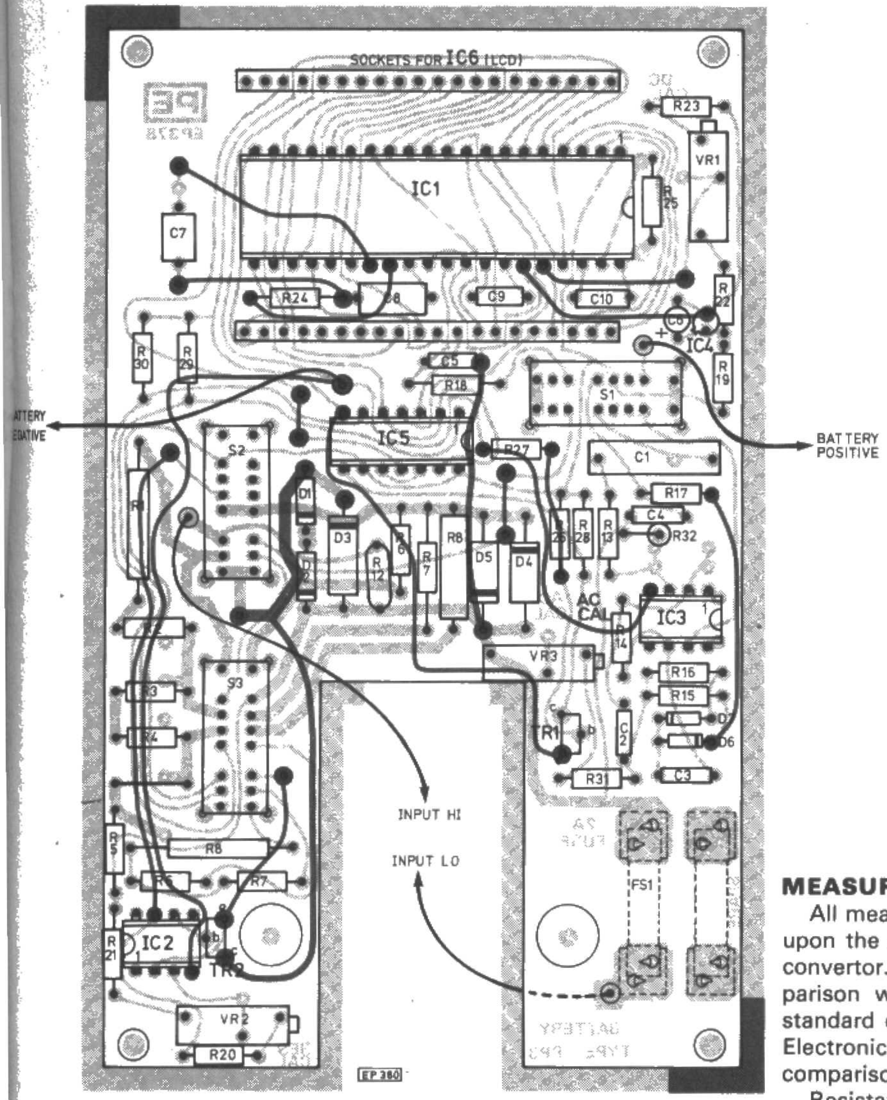


Fig. 5. Component assembly on p.c.b

At this stage, carefully check the board for any assembly errors and then ensure that all joints have been soldered, particularly all top-surface joints. Ensure that there are no short-circuits particularly around the integrated circuits and switches where connections are grouped close together.

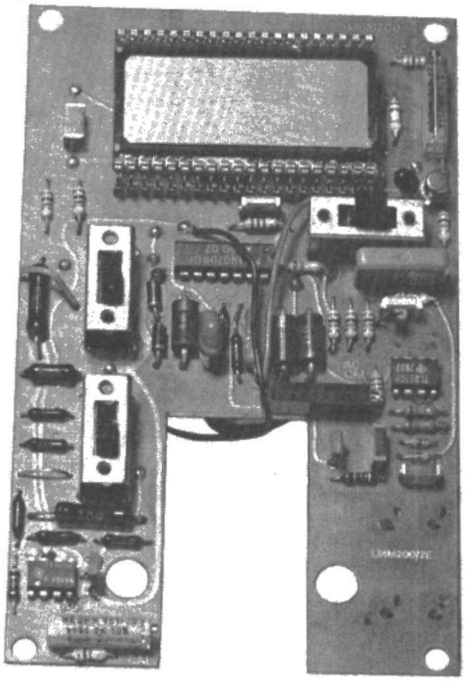
The liquid crystal display should be carefully removed from its packaging and gently inserted into the socket pins. The display pins are very fragile and it will be found easiest if one row of pins is located first but not pushed fully in. The second row should now be located in the sockets and after checking the location of all pins, the display may be pushed fully home.

TESTING AND CALIBRATION

After ensuring that there are no unsoldered joints or short-circuits the 2A fuse should be fitted and the protective film over the display removed.

Set S1 to d.c. position, S2 to V, and S3 to 20V range. With a PP3 battery connected to the supply leads the current consumption should be typically 2mA and the display should read 0·00 with the negative sign alternating. If an offset of one or two digits is present, an insulated wire link should be added to the underside of the board from C5 to D4 as shown on the component layout.

Measure the voltage between the Lo input lead and positive rail which should be between 2·4V and 3·2V.



MEASUREMENT DEPENDENCE

All measurements made by the instrument are dependent upon the setting of VR1 which adjusts the f.s.d. of the a/d convertor. D.c. calibration may be accomplished by comparison with a meter of known accuracy or by using a standard cell. A full calibration service is offered by Lascar Electronics. The a.c. voltage ranges should be calibrated by comparison techniques and VR3 adjusted accordingly.

Resistance ranges should be calibrated using standard resistors of 0·5% grade or better. With the input leads open-circuit the display should be 1 together with decimal point according to range selected, with the subsequent digits suppressed indicating overrange or infinite resistance. When the input leads are shorted together the display should be all zeros but on the 200 range there will be a small offset of two or three digits due to switch resistance.

Calibration of current ranges is not necessary but these ranges may be checked using standard resistors and a known voltage source.

FINAL ASSEMBLY

The 4mm input terminals should be fixed to the front of the instrument case and the self-adhesive foam strip positioned between the terminals inside the case to cushion the battery.

The moulded bezel should be fixed to the front of the case and the display window to the rear of the bezel.

The printed circuit board should be carefully located onto the four moulded pillars inside the case top, ensuring that the input and battery leads are accessible. Four spire clips are used to secure the board to the pillars. Input leads may now be soldered to the appropriate terminals and a PP3 battery clipped in place.

The instrument should be given a functional test and the lower half of the case may be secured using the four self-tapping screws provided. ★

NOTE:- R6, 7, 8 FIG 5 ABOVE LOWER LEFT
SHOULD BE R9, 10, 11 CORRECTION FROM P.E. SEPT 1980
P.21 OF Ⓙ

Video Information Centre...

In the words of celebrity tape cutter Alan Pascoe, "We've had the Old Vic, we've had the New Vic, now this is JVC's VIC". Kurt Lowy, JVC's Managing Director, explained its purpose, "The Video Information Centre is modelled on similar showrooms established by our company in Japan very successfully. It is the first one of its kind to be opened outside Japan. Its purpose is not only to promote JVC products but fundamentally to do really what the name signifies—provide an information centre for the public and the dealer" (I'm quoting from the text this time).

Unofficially, it was suggested that it was also to feed information back to the parent Victor Company of Japan on the trends in our small but relatively sophisticated market (explaining why America wasn't chosen, where video is already big business). It was further suggested that it was also part of JVC's preparations for a European confrontation with the new Philips/Grundig V2000 video format, which is a more advanced format than VHS. Both of which may well be true, but it is a fact that JVC have to date been the company most active in backing the home video concept so there's no inconsistency here. It will also be used for a comprehensive programme of dealer training.

Marketing politics aside, the VIC at 82 Piccadilly marks the beginning of a new stage in home video. A consolidation of the past couple of years of rather toe-dipping effort, and a more optimistic face set to the future. Underlining the point that, whatever changes do occur on the video scene—and they're likely to be many, the basic video-for-everyone concept is here to stay. At least until technology confronts us with some wonderful new way of recording the high-days and holidays of our lives. Even the chill winds of our economic winter are unlikely to cause more than a few shivers in the hallowed halls of consumerism.

PROBLEMS

Of course, there are still a few problems requiring attention. Mr. Kurt Lowy again, "The facts are that despite impressive amounts of TV and press advertising most potential users are still not aware to what use they can put a video tape recorder. Very few people realise how relatively economical it is to use video cameras, and that slides or home movies on film are transferrable to tape, as well as many other features." To prove this we were shown a tape recorded in Croydon, where the passers by were quizzed as to just what they did know. Not very much, except that it was damned expensive. So VIC has an uphill task ahead of it; to educate the populace into an awareness of the diverse potential of the video recorder, so that when it comes to emptying their bank accounts they'll do so secure in the knowledge that they're getting a bargain.

But the VIC is more than just a showroom and an information centre, it's also a small facilities house providing a variety of basic video services. Let me give you a guided tour of the place. By the plate glass front there's the Camera Corner, where people will be able to try out the current models on Green Park across the road and the passing Rolls Royces. There's the VHS Corner, displaying their range of video cassette recorders with monitors above to check the results. There's also a library of JVC and other pre-recorded cassettes for preview; such things as, "Iron Men and Steel Machines" a history of motor racing, and "The Bubblies" apparently a sensation on children's TV. And now the facilities. Telecine transfer, where film can be copied onto video tape—Standard and Super 8mm, 16mm, and 35mm slides, by prior arrangement of course. And an Album Video Corner, where photographs and printed matter can be copied, with the facility for adding a sound track via an audio cassette recorder. There's a fourth corner too, the Audio Video Corner featuring the latest of JVC's hi-fi and video home entertainment equipment.

It's the studio however, and its attendant facilities that form the productive hub of the place. Not a large studio—about 3 metres by 10 metres, but large enough for the simple programme production envisaged. For which there's 13·5kW of lighting and two cameras. One the CY 8800 EK—from the top of JVC's range, the other the GC 4100 EK—a high quality camera from their domestic range, married to a special effects generator and chromakey unit. From the main control room signals go to the editing room, where electronic editing is performed using U-Matic format video cassette recorders. There are also facilities for copying video tapes onto the VHS format in the dubbing room. As many as eight copies at a time from VHS, U-Matic, Beta or Philips VCR formats.

COMPETITION

If the tape's a good one, then a competition announced at the opening will seem like a heaven sent opportunity for its producer to go onto bigger things. It doesn't matter whether he or she is an amateur or a professional or what the subject is, the only requirement is that is shouldn't exceed twenty minutes. Presumably, life is just too short for the international panel of judges to have to sit through anything longer?? The winner of this Third Tokyo Video Festival will receive a trip to Japan, together with cash and equipment, and there will also be prizes for the runners up.

Also announced at the opening, was Matsushita's decision to adopt JVC's Video High Density capacitive video disc system in preference to their own pressure pick-up system (the two companies having close financial ties). A predictable move which now leaves just three systems in the running; the other two being the Philips Video Laser Player—being test marketed in Atlanta, Dallas and Seattle, and RCA's Selectavision—which is also being readied for market. JVC's system also allows digital audio discs to be played, by connecting a PCM decoder.

When the VIC's first anniversary is celebrated on the 12th of February next, the battle between the rival video disc systems should just be getting under way in earnest. With fortunes riding on the results, it should prove very interesting.

Reginald Miles

PE DFM

THE FOLLOWING design is for a battery operated pocket frequency meter, with a basic range of 10Hz to more than 2MHz. This design incorporates a unit-counter facility and a battery voltage monitoring circuit. Also an on board voltage regulator is provided, enabling the unit to be powered from dry cells, calculator PSU or car battery (via the cigar lighter socket). The meter could be used with the Prescaler module to give a digital readout of a mobile radio transmitter. This design offers a considerable cost saving over similar units, but with a *very* professional finish.

FEATURES

The Frequency meter has a large 6 digit liquid crystal display of which 4½ digits are used by the counter chip, and the 6th as a flag to indicate range and battery condition. A l.c.d. is used in preference to l.e.d. so as to prolong battery life; the prototype consumed only 5mA with all segments on.

In the Unit counter mode the meter acts as an electronic totalizer with a maximum count of 19,999. There are two frequency ranges 0-20KHz with a resolution of 1Hz, and 0-3MHz with 1KHz resolution. However, it is possible to obtain 1Hz resolution by switching to the lower range.

A socket is provided to power a VHF prescaler, and the decimal point is automatically shifted when the plug is inserted. Construction is greatly simplified by the use of a single p.c.b. which holds all components except sockets.

SPECIFICATION

Power supply	9V PP3 battery or external d.c. supply 8-20V.
Frequency range	0-2MHz (0 to over 150MHz with prescaler).
Ranges	0-20KHz 1Hz resolution (KHz). 0-5MHz 1KHz resolution (MHz). 10-150MHz with Prescaler.
Unit counter	0-19,999 units.
Display	6 digit l.c.d. (4½ digits used for counter).
Input voltage	200mV-20V.
Accuracy	±1 digit depending on crystal timebase typically 20ppm.
Size	168mm × 90mm × 32mm (including sockets).

D.MOTTRAM

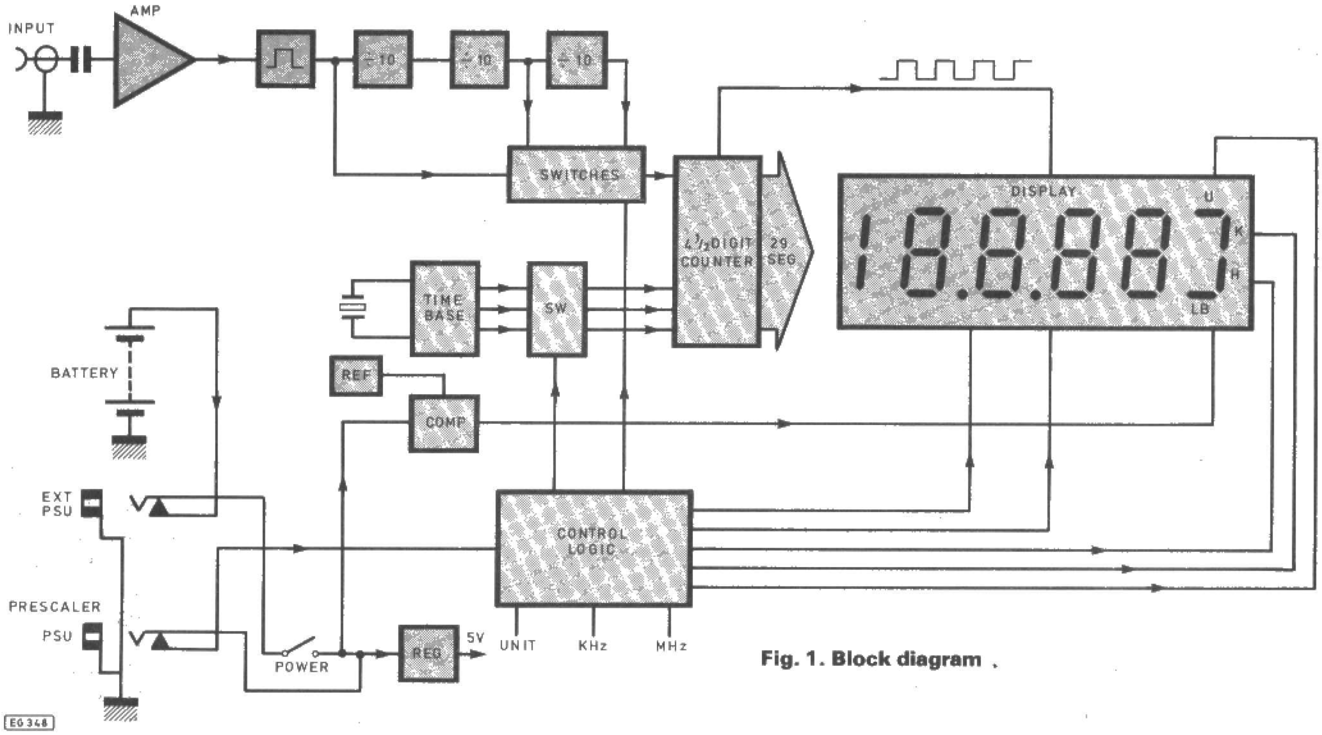


Fig. 1. Block diagram.

CIRCUIT DESCRIPTION

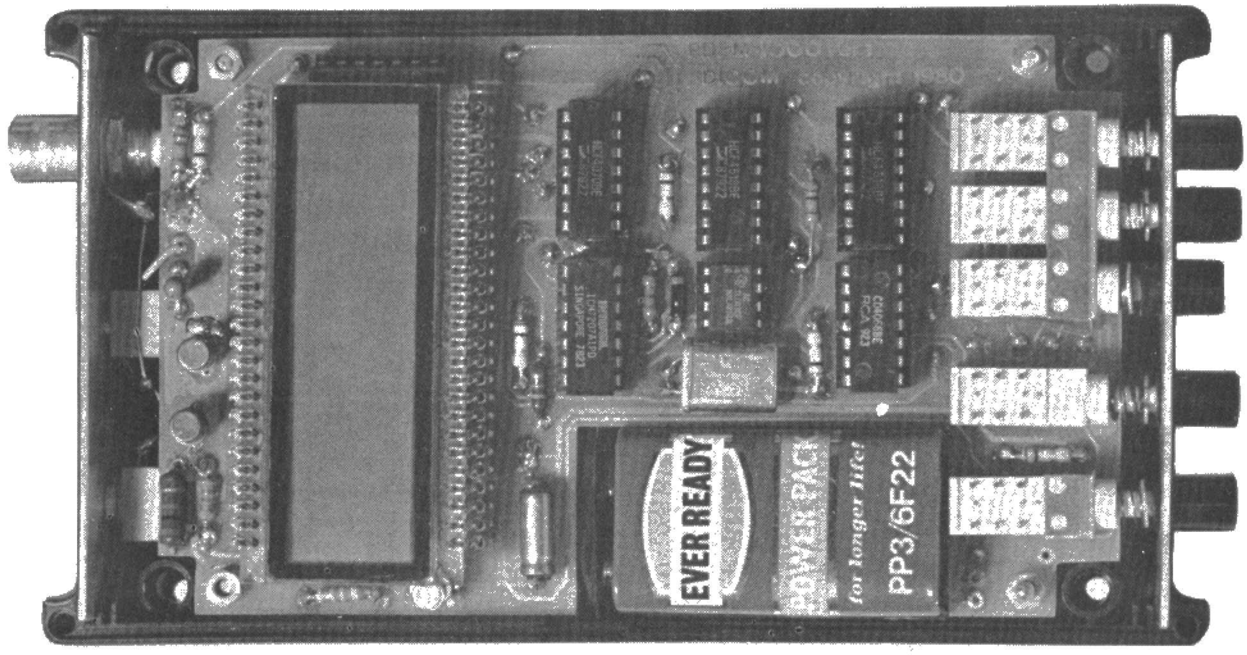
Transistors 1 and 2 form a simple but very effective buffer stage, with an a.c. coupled input, which is very useful when measuring a signal with high d.c. bias. The output from the buffer is fed to a Schmit inverter IC1d which "cleans up" the signal before feeding to the counters. The decade counters IC 5-7 and switches IC8, S1, 2, 3 divide the input signal by 1, 100 or 1000 (depending on range). With the prescaler unplugged, the signal is divided by 1 or 1000 (KHz & MHz respectively), when the plug is inserted pins 5 & 6 of IC1 are forced low by R1, enabling the divider chain to divide by 100. With the prescaler plug inserted the decimal point is automatically positioned correctly.

FREQUENCY MEASUREMENT

The timebase consists of a single chip IC4 (7207A) and a crystal, the frequency of which is 5·24288MHz which is unusual, but can be obtained with the 7207A as a kit from most Intersil distributors. The gate sample time is kept at one second regardless of range, the reason for this is that l.c.d.s have a slow response time. The last digit would become *blurred* with a faster gate time.

Fig. 3. shows the sequence of events when in the frequency counter mode.

1) The counters are enabled for 1 second.
2) After the counters are disabled the display latches are updated and then frozen.
3) Then the counters are reset and the cycle is repeated.



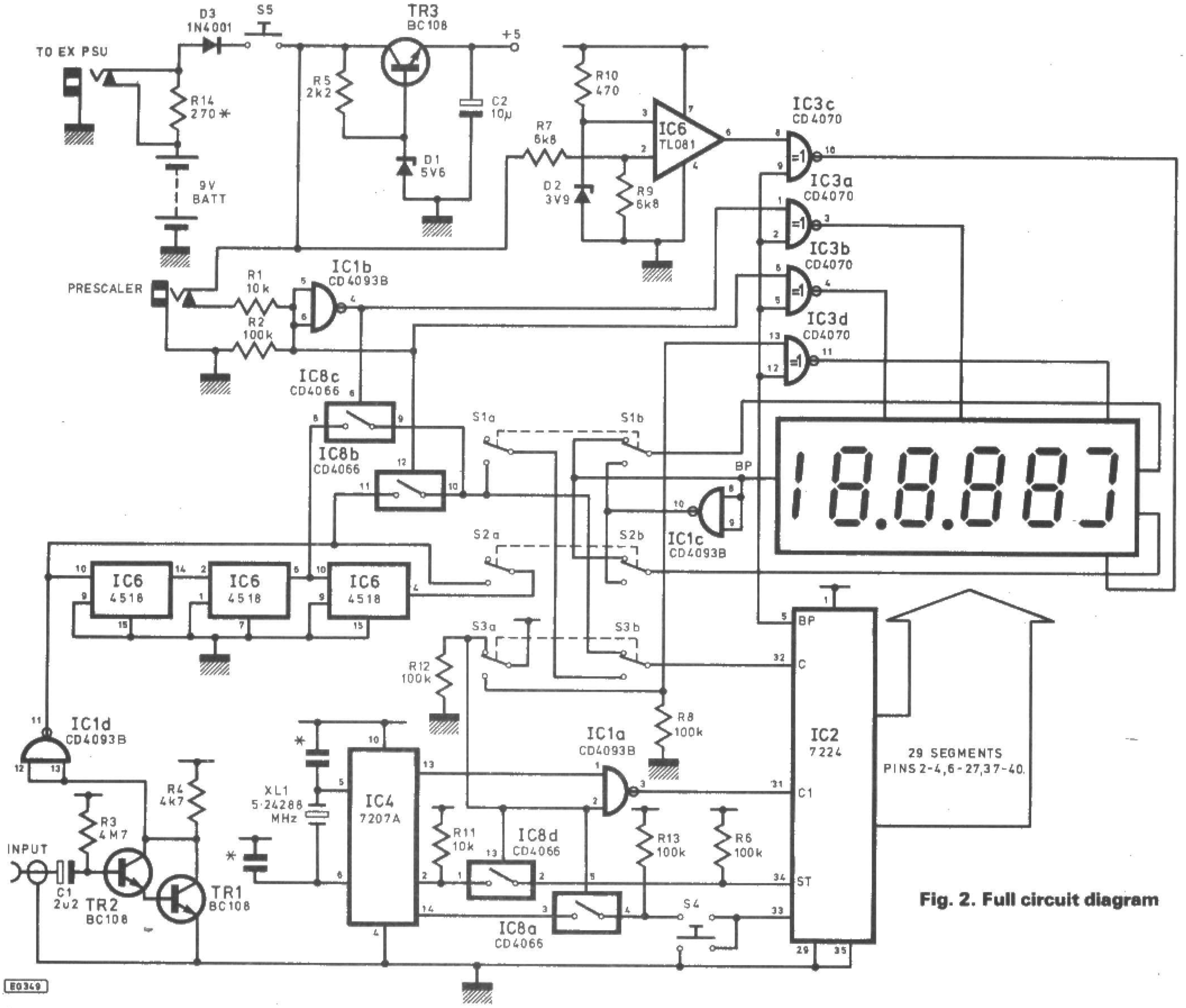
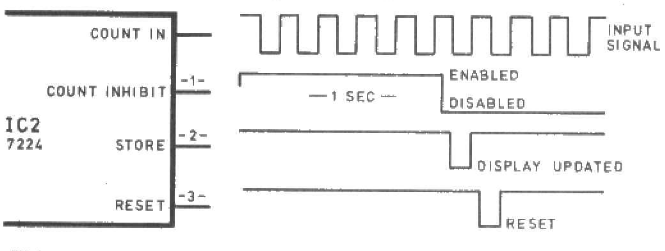


Fig. 2. Full circuit diagram

Fig. 3. Timing



UNIT COUNT MODE

In the Unit count mode, switch 3a takes IC1 pin 2 low, thereby permanently enabling the counters, also the analogue switches of IC8 disconnect the timebase, store and reset outputs and resistors R6 and R13 take IC2 pins 34, 33 low and high respectively. In this state IC2 acts as a basic counter with S4a as the reset.

LCD DRIVERS

The counter chip IC2 produces a back-plane output and all $4\frac{1}{2}$ digits are controlled directly.

Fig. 5. shows two methods of producing the signals for the flags and decimal points. In the first, the KHz and MHz

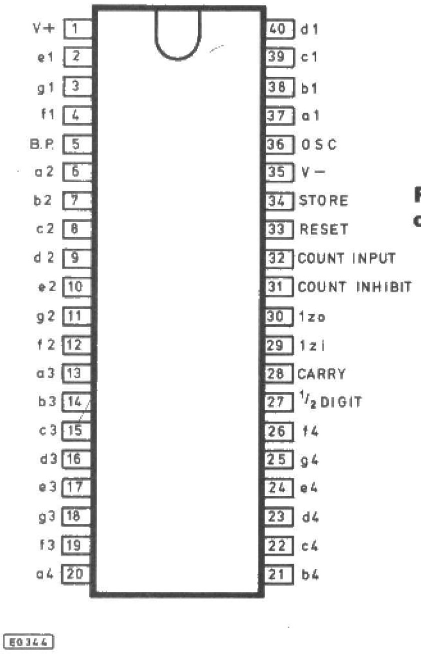
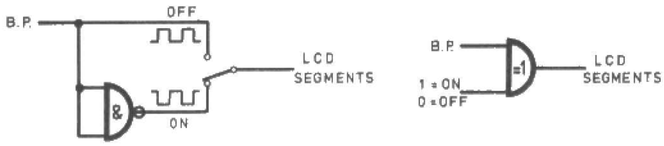


Fig. 4. ICM 7224 pin-outs (IC2)

flags are controlled by switches 1a and 2a, which select either BP or inverted BP ($\overline{BP}$). Another method is to use an exclusive OR gate as a programmable inverter.



EG346 **Fig. 5. LCD drivers**

VOLTAGE REGULATORS AND MONITOR

TR3, D1 and R5 form a simple voltage regulator and as the current consumption of the unit is very low the transistor does not require a heat sink.

The Low Battery indicator is controlled by IC6 which compares the battery voltage with a reference made with D2 and R10, if the voltage across R9 is less than the reference (3·9V) IC6's output swings high turning on the Low Battery flag.

If Nickel-Cadmium batteries are to be used, they can be charged by using a 9V calculator PSU, an additional wire and a resistor (14) are required.

CONSTRUCTION

All components except the sockets and battery are mounted on one double sided p.c.b. To save the high cost of plated-through holes, solder pins are used to connect the two sides.

Start by cutting out the pieces from the p.c.b. as shown in Fig. 6. Insert and solder the solder pins and cut off the excess stem. Solder in all the resistors and capacitors, diodes and transistors (solder all leads on both sides). Do not force the resistors in place as the paint is easily damaged, revealing the metal end-caps, which could short against the p.c.b. tracks. I.c. sockets and Soldercon pins should be used as the board is easily damaged when unsoldering faulty i.c.'s, Soldercon pins are used for the display and IC2 as there are a few solder pins under the chip which prohibits the use of a 40 pin socket. The crystal is held in place by a pad of double sided sticky tape and the leads are soldered on both sides. Solder in the switches and insert all i.c.'s and the display.

Clean the board with meth's or thinners, and wire the three sockets and the battery lead as in Fig. 8, and re-check all components and wiring. Make sure that the display is in the right way around, and that none of the pins is touching.

TESTING AND CALIBRATION

Connect a PP3 battery and switch on, press the reset button and the display should read four zeros with a decimal point before the third digit, if not *switch off immediately*.

Apply a signal of known frequency to the input (eg. 50Hz from a low voltage transformer). If the meter does not give the correct reading check the input circuit and timebase with a logic probe or scope if available.

To check the battery monitor circuit, connect a variable PSU or a poor battery, the "Low Battery" flag comes on at about 7·5V which means the battery still has plenty of life left.

As for calibration, once the meter has been proved to work there is only the crystal to be trimmed, by adding capacitors to the pads on the under side of the p.c.b. Although the crystal frequency can be trimmed, the accuracy of the unaltered timebase is extremely high.

COMPONENTS . . .

Resistors

R1, R11	10k (2 off)
R2, R6, R8, R12, R13	100k (5 off)
R3	4M7
R4	4k7
R5	2k2
R7, R9	6k8 (2 off)
R10	470
R14	270 See text

All resistors ¼W 5%

Capacitors

C1	2µ1 tant. bead
C2	10µ axial elect.

Transistors and Diodes

D1	5V6 Zener 400mW
D2	3V9 Zener 400mW
D3	1N4001
TR1-TR3	BC108 (3 off)

Integrated Circuits

IC1	CD4093B
IC2	ICM7224
IC3	CD4070
IC4	ICM7227A
IC5	CD4518B
IC6	TL081
IC7	CD4518B
IC8	CD4066

Display

X1	6-digit l.c.d. 40-pin d.i.l. display

Switches

S1-S3	3-way interlocking
S4	1-way push-to-make
S5	1-way push-to-make/push-to-break

Miscellaneous

X1	5·24288MHz

Soldercon pins
Sockets for i.c.s
BNC connectors
2·5mm and 3·5mm jack sockets
Case—Bocon Major BOC 707
PP3 battery
Perspex for Bezel

A complete kit of parts is available from **Watford Electronics**.

FINAL ASSEMBLY

Cut out a rectangular window (32mm × 75mm) in the box with an Abrafile. See Fig. 9. Screw four pieces of 6BA studding, 15mm long, into four of the plastic bushes and remove the other two bushes with a pair of cutters. Fit four 5mm spacers over the studding and fit 6BA nuts on top, but not on the two at the switch end of the case. Fix the p.c.b. and panels in place with 6BA nuts and washers.

A simple display bezel can be made with a piece of 1·5mm perspex, and using white Letraset on a piece of thin black card behind, the bezel is held in place with four 8BA nuts and bolts.

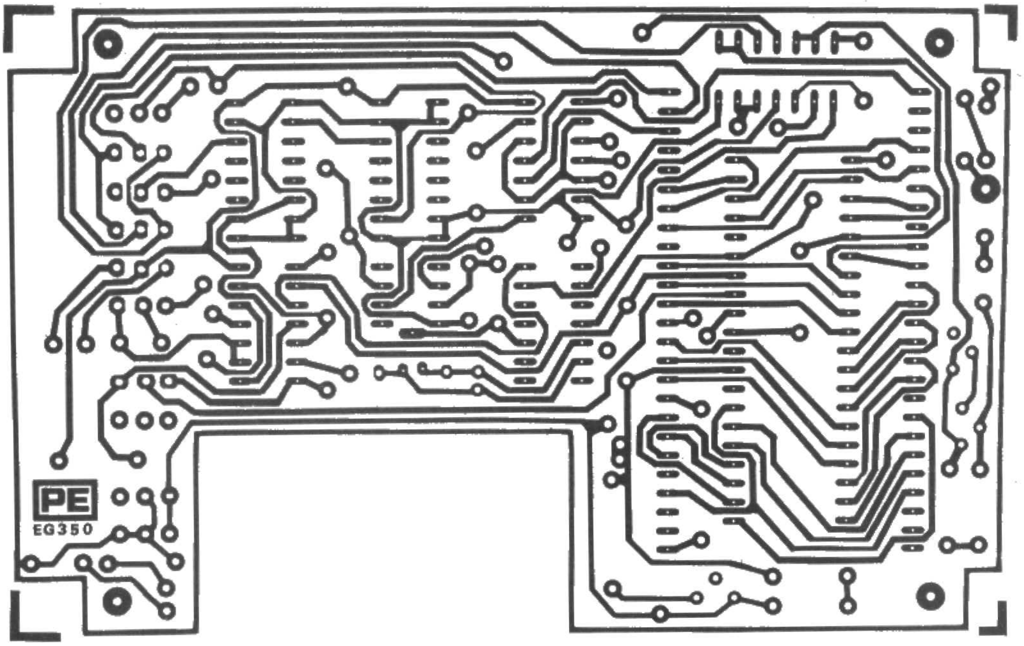
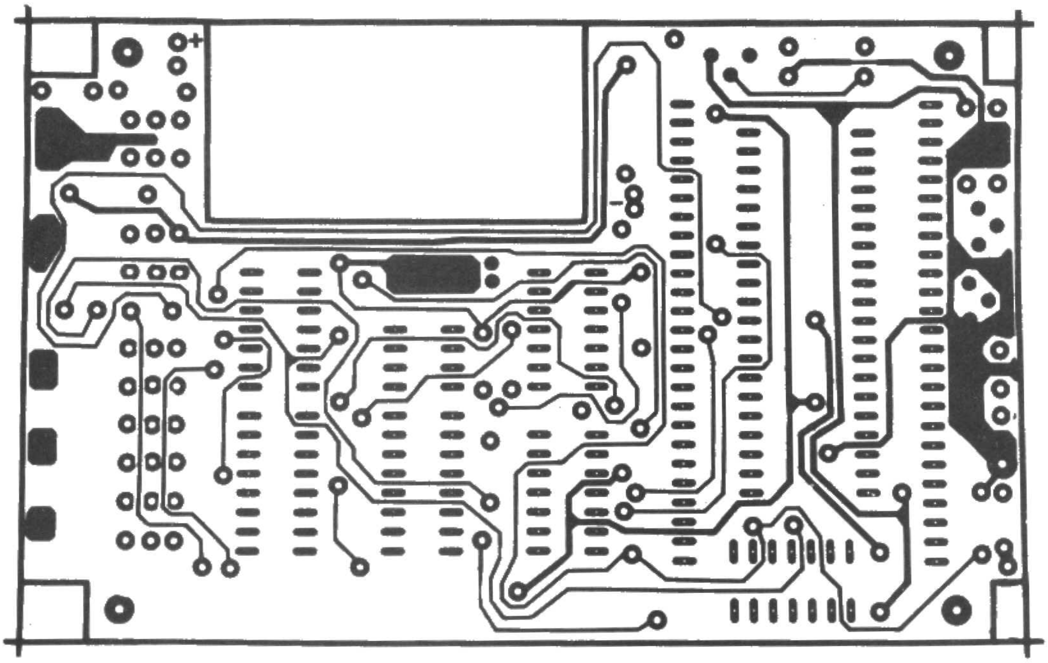


Fig. 6. Printed circuit layout (actual size)

Fig. 7. Printed circuit layout (component side)



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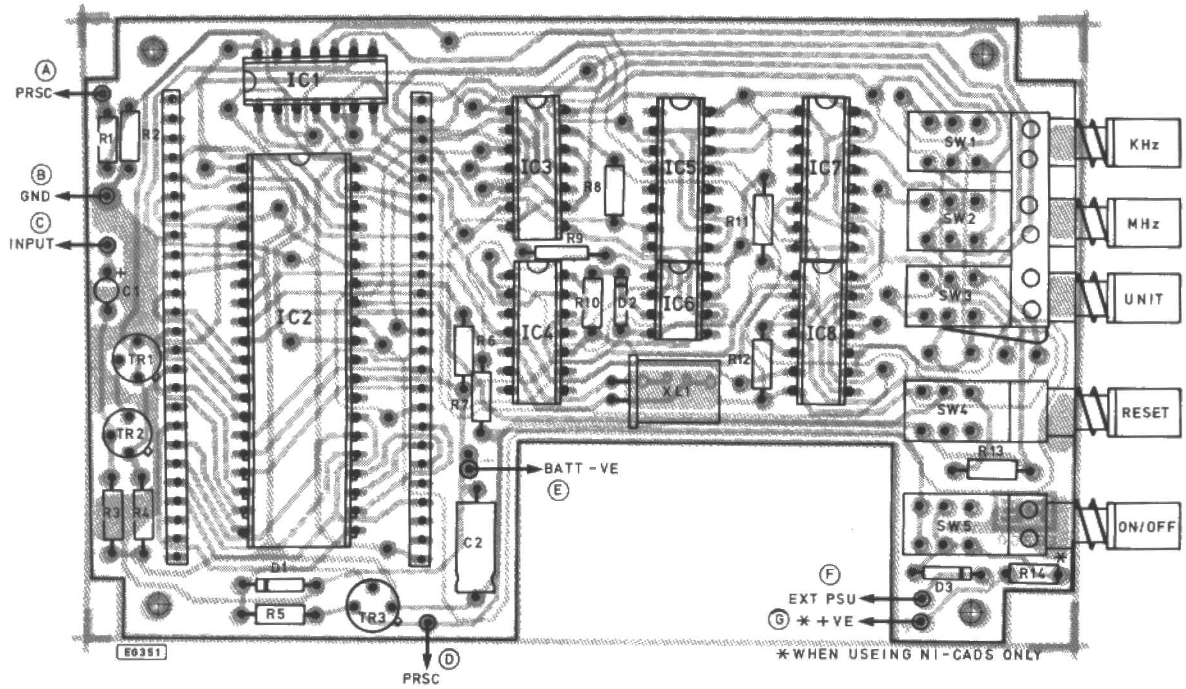


Fig. 8. Component overlay

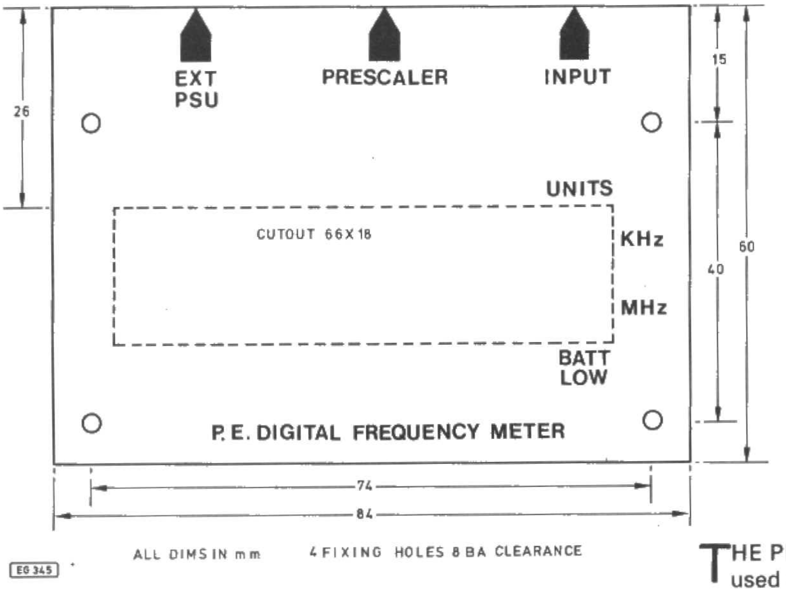
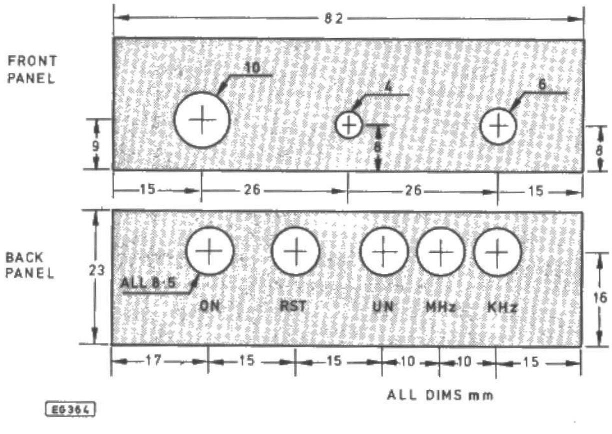


Fig. 9. Fascia label for DFM (actual size)

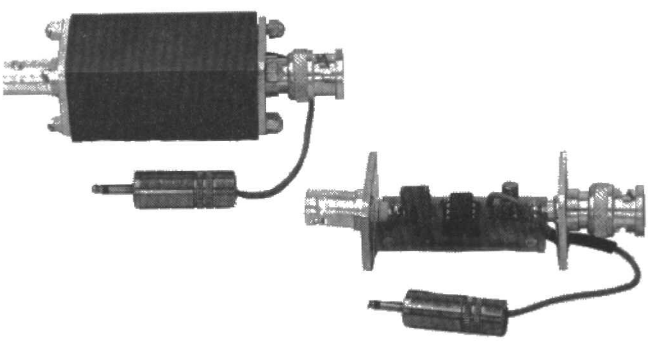
The battery is held in place with pieces of foam rubber glued to the case (four strips of self adhesive draft proofing is ideal).

Fig. 10. Drillings for front and rear panels



PRESCALER

THE PRESCALER to be described here was designed to be used with the PE Digital Multimeter, although it could be used with almost any frequency meter. The prescaler extends the measuring range to over 150MHz (typically—200MHz) making it ideal for 2m work. The circuit is built into a module that plugs in between the frequency meter signal input socket and test lead (or whip aerial). The unit also has an onboard voltage regulator with a supply range of about 8-18VDC.



CIRCUIT DESCRIPTION

The i.c. used is an Emitter Coupled Logic (ECL) prescaler manufactured by Plessey. It has a fixed division ratio of 100, that is, if a signal of 150MHz is applied at the input, the output frequency is 1.5MHz. The output stage is similar to low power Schottky TTL at 5V, so should be well within the range of most frequency meters. The chip has an on-board Zener diode, therefore providing a regulator is simply a matter of adding a transistor, and as the current consumption of the i.c. at 5V is only 35mA TR1 does not require a heatsink.

The maximum input frequency depends on the slew rate of the signal; if a square wave with a fast rise time is applied, the unit can be used down to d.c. Although for *practical* reasons the minimum input frequency should be limited to 10MHz. Resistor R3 should only be added if the circuit starts to oscillate with the input disconnected, as it reduces the sensitivity of the prescaler circuit.

CONSTRUCTION

All components are mounted on the one p.c.b.. do not insert R3 until the unit has been tested. An i.c. socket should be used for IC1 as the p.c.b. may be damaged if the chip has to be removed. Drill a small hole in the end of the case for the supply lead, see Fig 14. The p.c.b. should then be inserted into the case and held in place by the two solder tags.

THE PROTOTYPE

The prototype was tested using a high frequency signal generator which had a low output voltage, but worked very well when used with the prescaler. The author found that the unit measured from about 10MHz to over 200MHz with a very high degree of accuracy. Also the prototype worked reliably down to 100mV and did not require a resistor across the input to prevent oscillation. ★

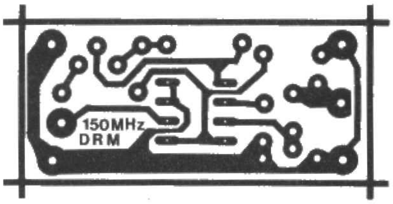


Fig. 12. Printed circuit layout (actual size)

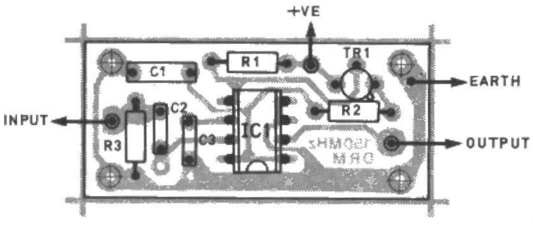


Fig. 13. Component overlay

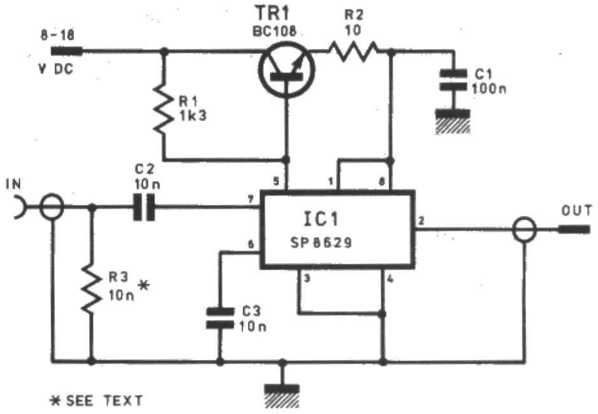


Fig. 11. Circuit diagram of Prescaler

PRESCALER COMPONENTS

Resistors

R1	1k3
R2	10
R3	100k see text

All resistors ¼W 5%

Capacitors

C1	100n Polystyrene
C2, C3	10n Ceramic (2 off)

Transistors

TR1	BC108

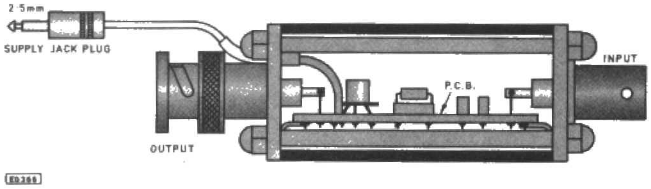
Integrated Circuits

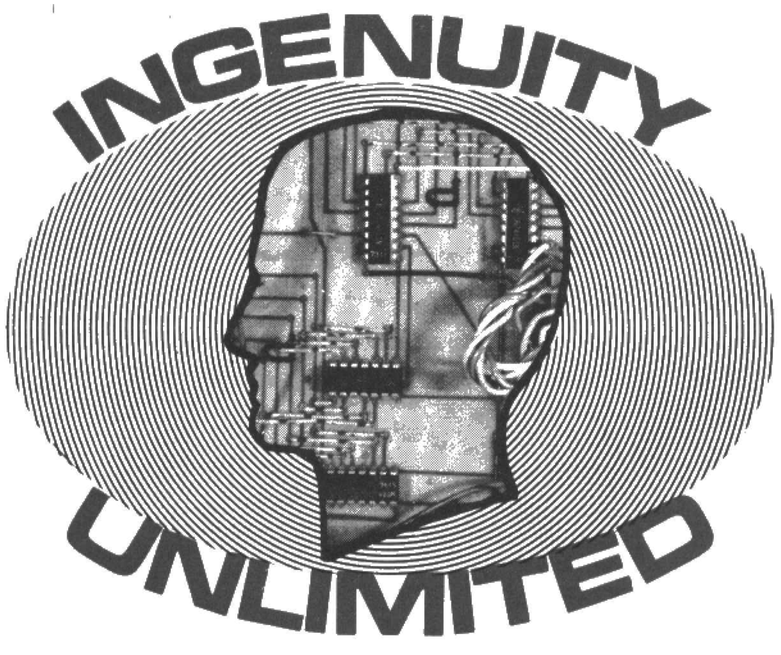
IC1	SP8629 (Plessey)

Miscellaneous

Case, BNC module, p.c.b., 2·5mm jack plug, 8 pin i.c. socket, p.c.b.

Fig. 14. Mechanical construction



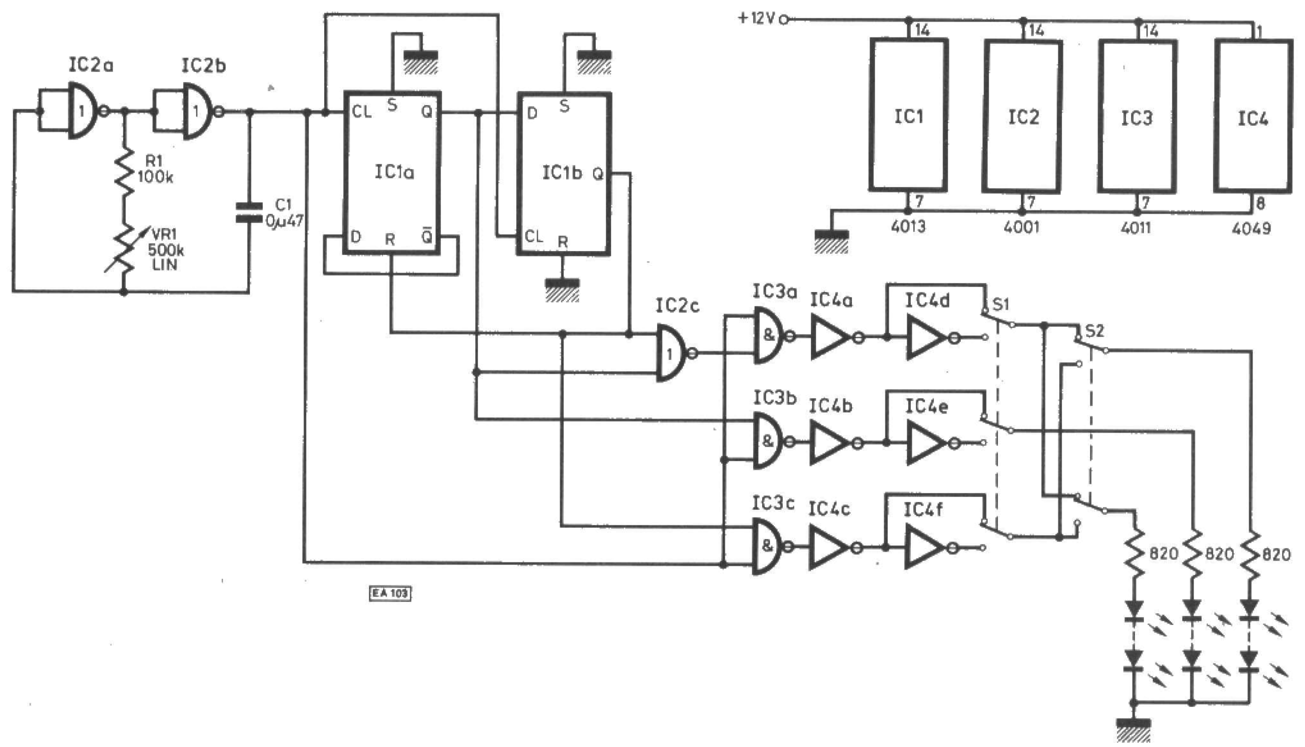


A selection of readers' original circuit ideas. It should be emphasised that these designs have not been proven by us. They will at any rate stimulate further thought.

Why not submit *your* idea? Any idea published will be awarded payment according to its merits.

Articles submitted for publication should conform to the usual practices of this journal, e.g. with regard to abbreviations and circuit symbols. Diagrams should be on separate sheets, not inserted in the text.

Each idea submitted must be accompanied by a declaration to the effect that it is the original work of the undersigned, and that it has not been offered or accepted for publication elsewhere.



MOVING LIGHTS

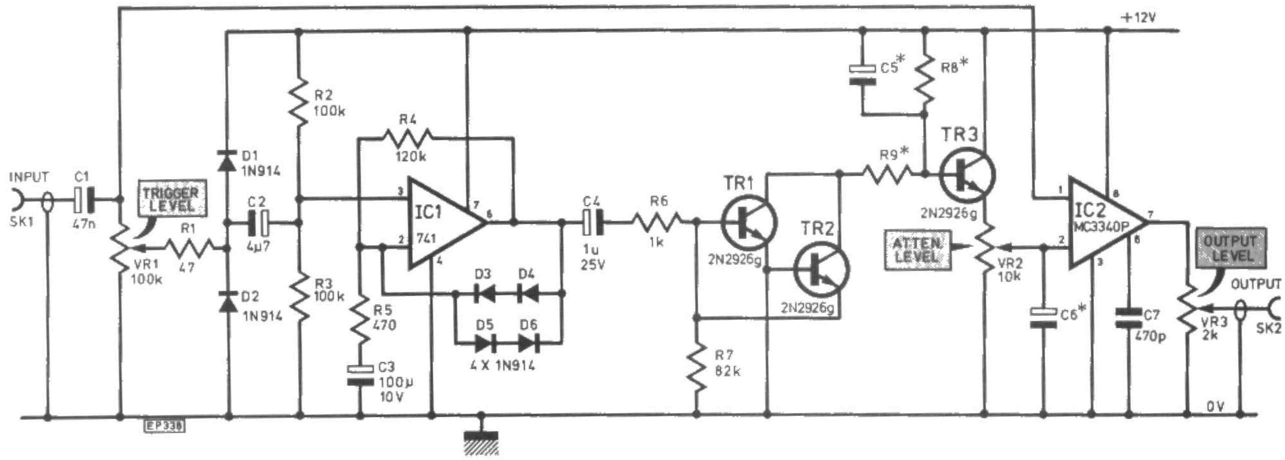
THE display is built around IC1 which is wired in a three phase clock configuration. The clock is driven by the variable frequency oscillator formed by the two gates of IC2. The components used were found to give a good range of speeds.

The output from the clock is fed to one of the NAND gate inputs and the other is connected to the oscillator. This was found to give a more well defined display. IC4 was used to buffer the outputs and S1 was incorporated to produce either one on and two off or vice versa at the display.

S2 is a reverse switch. The prototype display consisted of six l.e.d.s in series with an 820 ohm resistor for each output and the whole system operated from a twelve volt supply.

A. W. Cunningham,
Strathblane,
Glasgow.

NOISE GATE



A full complement of effects pedal, while providing sound variety to a performer, can be a pain in the neck in circumstances where gains are left high and nothing's going on. Here is a circuit to overcome this at a fraction of the cost of its commercial equivalent:

When a d.c. voltage is applied to pins 2 and 3 of IC2 it will attenuate the signal. 3 volts gives no attenuation.

R1 and C1 control the rise time of the switch and therefore switching TR3 on through VR1 into the control input of the MC3340P. VR1 controls the voltage and therefore the amount of attenuation.

R2, C1 and C2 control the release time and will both be fairly low, i.e. 1—10uF. The higher the value then the slower the release time.

The unit will work on a PP3 but VR1 will have to be lower and it is better to keep the instruments volume control flat out, and use the trigger level instead or a substantial amount of signal may be lost in quiet passages.

C. Bishop,
New Barnet,
Herts.

MODEL TRAFFIC LIGHTS

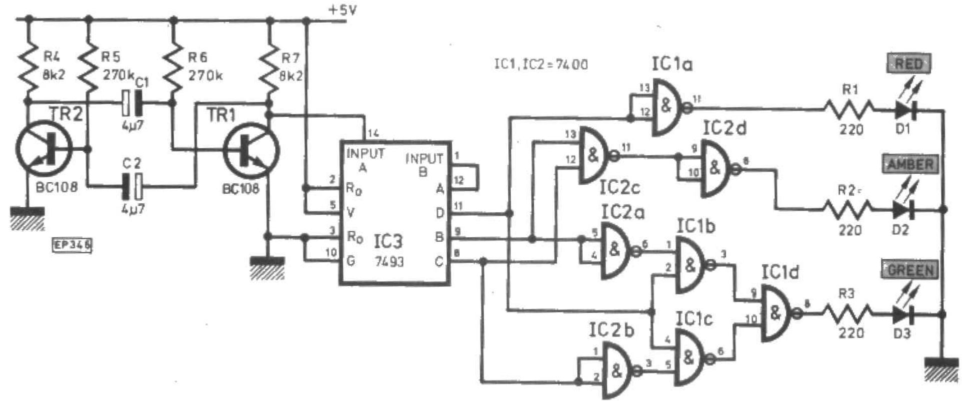


Fig. 1 ▲

IN Fig. 1 TR1 and TR2 form an astable multivibrator with an operating frequency of about 0·5Hz. The output from TR1 collector drives a 7493 four bit binary counter. Two 7400 i.c.s decode the counter output and drive the three l.e.d.s.

The complete cycle of operations takes about 32 seconds and the l.e.d.s are on as follows:

Green	12 seconds
Amber	4 seconds
Red	12 seconds
Red and Amber	4 seconds

If required to simulate operating at a crossroads, a single 7400 i.c. will drive a complementary set of l.e.d.s as shown in Fig. 2.

M. J. Rendle,
Hooe,
Plymouth.

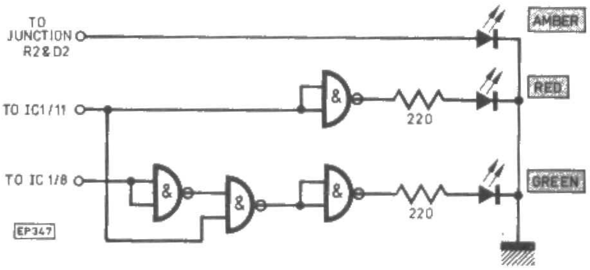
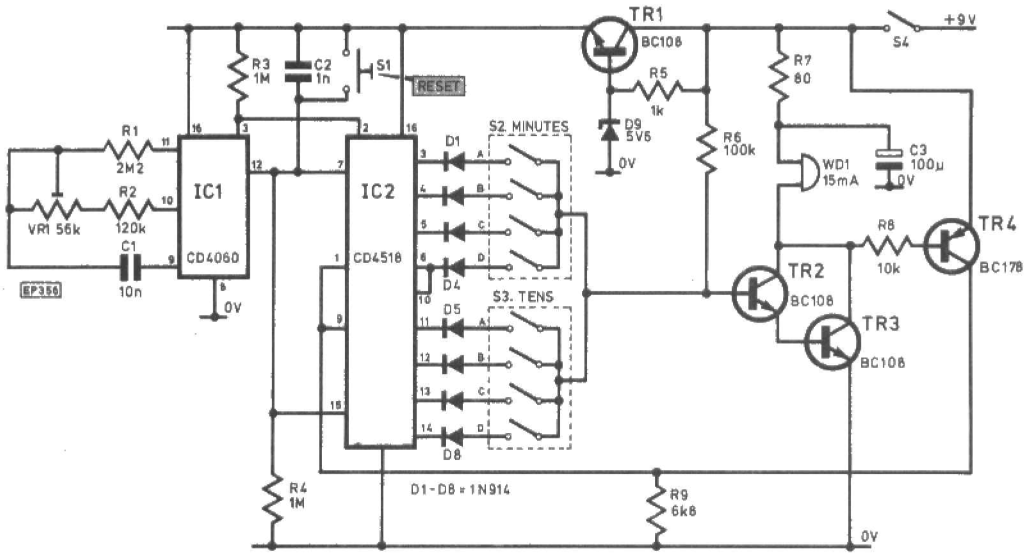


Fig. 2 ▲



ACCURATE KITCHEN TIMER

THE method of pulse-count selection embodied in this circuit may be new to some readers and has many other applications where a simple, and above all presentable, means of selecting 0 to 99 (or more) steps is required.

IC1 is a 14-bit binary counter fed by a trimmable oscillator, resulting at pin 3, one negative going pulse per minute; these pulses clock the two cascaded BCD counters in the CD4518. The required time is selected on the two (minutes, and tens of minutes) thumbwheel BCD switches thus inhibiting the alarm through the NOR gates formed by the diodes. At the end of the set time all diodes will be reverse biased and the alarm sounds and latches on by disenabling the 4518; the timer is silenced by switching off or, if the same period is required immediately, pressing the reset button.

Accuracy of 0·5 per cent (0·9 of a second on a 3 minute egg) was obtained in prototypes, down to a supply of 6·5 volts: at about 4mA 'counting' current a 9 volt battery lasts for many months.

The simplicity and accuracy of this form of selection is a great improvement on any mechanical timer and using one i.c. and two switches to access any digit in a count of 100 is economical too.

David Ian,
East Molesey,
Surrey.

TTL/CMOS DEBOUNCED SWITCH

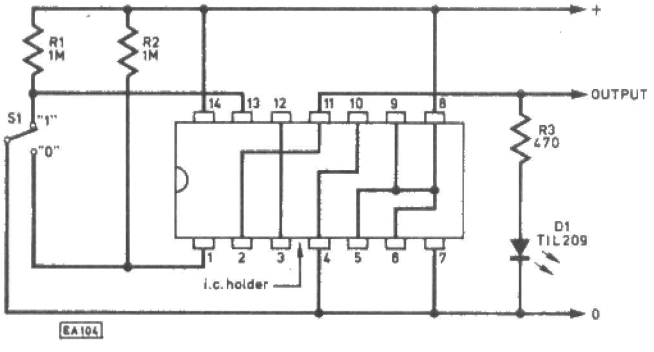
A debounced switch is a necessity when experimenting with logic circuits, especially flip-flops and counters. The switch described here has been designed so that, simply by changing the i.c., it can be used with either the TTL or CMOS logic families.

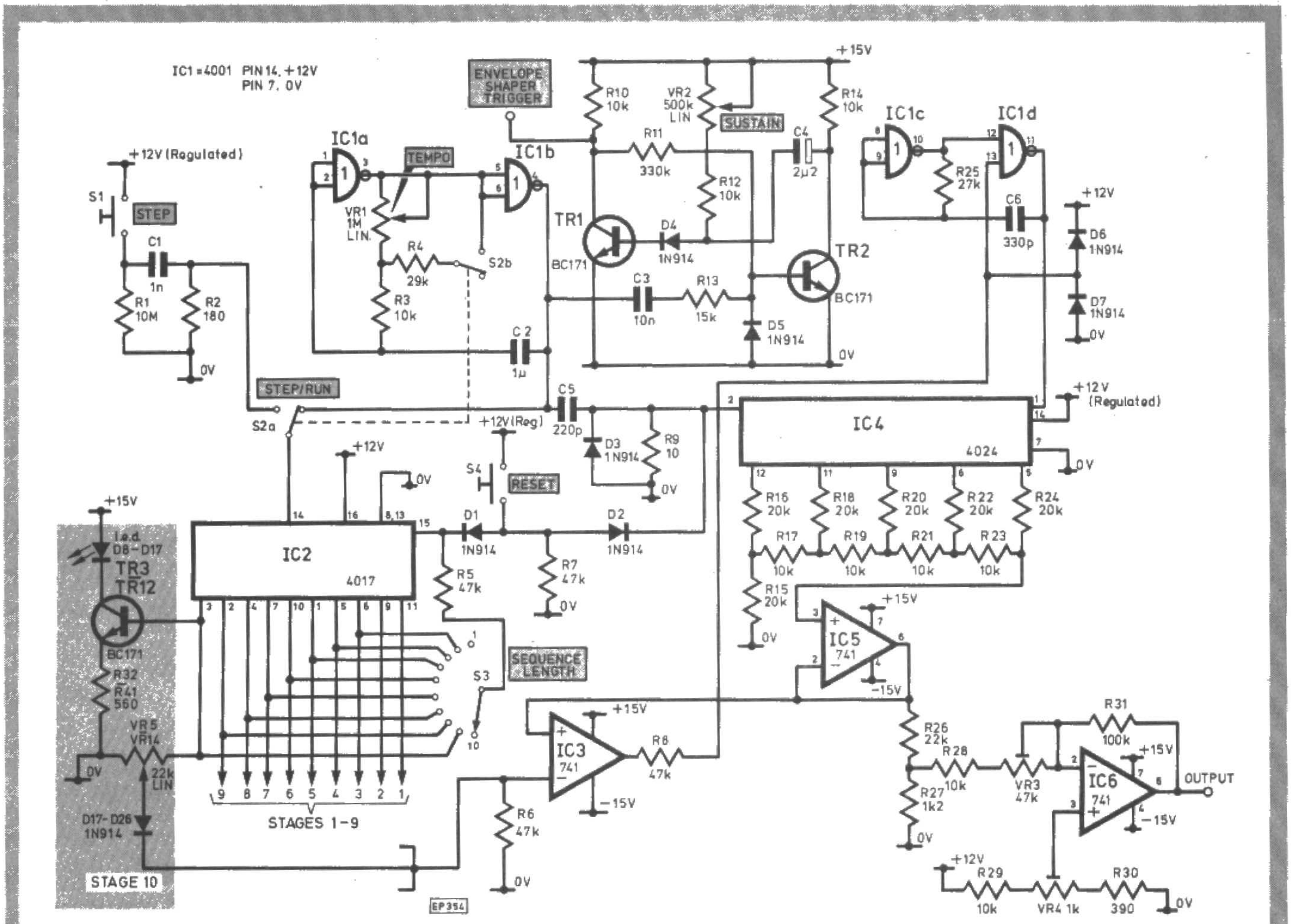
The circuit is basically a simple R–S bistable built round a 14-pin d.i.l. i.c. holder. When the unit is to be used with TTL logic a 7400 is inserted in the holder, while with CMOS logic a 4011 is employed. Both these i.c.s are quad 2-input NAND gates, only the gates connected to pins 1, 2, 3 and 12, 13, 14 being used (these pin connections are the same in both i.c.s).

Although unused TTL inputs can be left floating, unused CMOS inputs must be tied to one or other of the supply rails—R1 and R2 satisfy this requirement. Unused CMOS gates must be similarly dealt with, but in this case there is a problem in that the unused gate connections of the 7400 and 4011 do not coincide; however by connecting them in the combination shown, the NAND truth table is observed for either of the i.c.s.

The switch is powered from the circuit being experimented on, and the l.e.d., of course, indicates the logic state of the output.

A. F. Olivera,
Varyl Begg,
Gibraltar.





STEPSET SEQUENCER

THERE are two main types of sequencer commonly used with synthesisers: those which are programmed by using the instrument keyboard, and those which are set up using a bank of potentiometers. There are advantages and disadvantages associated with both types. The main advantage of the potentiometer system is that the sequence can be altered while it is running. A distinct advantage of the keyboard system is the speed and accuracy with which it can be set up.

The circuit described here was designed to include both these advantages. It uses a bank of ten potentiometers for programming, but to attain the speed and accuracy desired, adjustment of the potentiometers causes the unit's output voltage to vary in steps, each step being equivalent to a one semitone change in the frequency of the synthesiser's oscillators. Each of the potentiometers can be positioned to select any one of the 32 available discrete steps, giving a range of 32 semitones or about two and a half octaves.

IC1a forms a clock oscillator variable from 0·75Hz to 55Hz, which determines the tempo of the sequence. The clock pulses thus produced are used to step the decade counter, IC2 which sequentially addresses the programming potentiometers, VR5 to VR14. The l.e.d.s, D8 to D17 are also sequentially addressed to indicate which potentiometer is being addressed. The voltage tapped from each sequenced potentiometer is routed to the comparator, IC3 which compares the potentiometer voltage with the output from the D-A converter. The D-A converter is formed by IC4, a 7-stage binary counter; R15-R24, the R/2R network; and IC5, the buffer amplifier. If the potentiometer voltage is higher than the D-A voltage, the output of IC3 will swing negative enabling the 50kHz oscillator, IC1b. This causes IC4 to count up until the D-A voltage exceeds the potentiometer voltage, when the output of IC3 will swing positive, inhibiting the 50kHz oscillator. IC4 is reset each time the sequencer steps so that the count always starts at zero. The D-A voltge is inverted by IC6 and passed to the output VR4 sets the output offset voltage ("tune" control), and VR3 sets the output voltage law which can be between 0·5V/octave and 1V/octave. This should be adjusted so that one semitone steps are generated in the synthesiser. Since IC6 inverts the D-A vóltage, VR5 to VR14 must be wired so that their top ends are at 0v.

An envelope shaper trigger is available from the monostable formed around TR1 and TR2. This generates sustain times from 15ms to 0·75s.

The sequencer can be single stepped with S2 in the "step" position, by pressing S1. In this mode, the tempo generator runs at 10Hz so that IC4 is reset frequently to allow the D-A converter to follow changing potentiometer voltages.

The sequence length can be altered between 2 and 10 steps using S3, which determines the reset point. Manual reset is possible using S4.

P. R. Williams,
Stevenage,
Herts.

Readout...

A selection from our Postbag

Readers requiring a reply to any letter must include a stamped addressed envelope.
Opinions expressed in Readout are not necessarily endorsed by the publishers of Practical Electronics.

Doram Diagram

Sir—Some time ago I purchased a Doram signal generator, order code 991-906 which provided an audio signal from 20 Hz to 20 KHz with variable amplitude for system testing and signal tracing. This kit was obtained from the old Doram Electronics Ltd. in Leeds but unfortunately the instructions and circuit diagram were not included in the kit. Though the company is now back in business, they are unable to supply the necessary information.

My reason for writing to you, is to ask whether you have on file or, could obtain from your readers, the circuit diagram and instructions for making up this kit. All the parts, including the box were thoughtfully provided, but without the requisite circuit diagram, it is not possible for me to make up the signal generator.

J. C. Benson
Reigate

Can anybody help?—Ed.

Attention Computer Users!

Sir—May we publicise the long-overdue founding of the National Personal Computer Users Association, which is intended to pool the vast combined computing resources of owners and users of all types of personal computers in the United Kingdom and to disseminate information between members.

Hardware, software, applications and programming enquiries involving a wide variety of machine code and high level languages are routed through the Association in order that members may take advantage of the experiences of owners of machines similar to their own. Programs, subroutines, software information and useful ROM routines and RAM locations not publicised by manufacturers will, of course, be of particular interest to other members and will be included in regular newletters. In addition various national research projects proposed by members are undertaken, the current one being the analysis of human speech dialects.

Naturally the Association is also able to provide consensus opinions of its' wide membership to organisations and publications involved in servicing the personal computer industry while maintaining the complete anonymity of its' members and to purchase hardware at bulk discount prices on behalf of members when practicable.

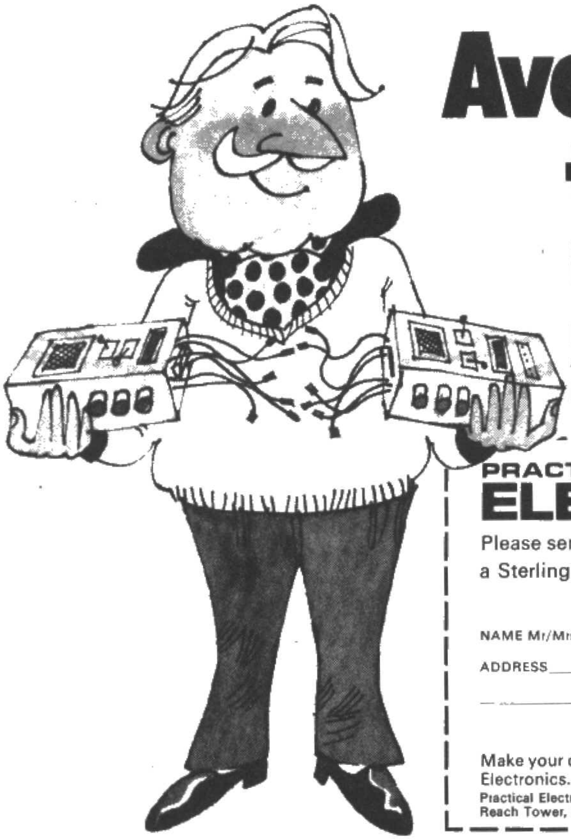
A nominal annual subscription of £8 is necessary to cover overheads, and membership application forms will be provided on receipt of an S.A.E.

E. J. Keeley,
NPCUA,
11, Spratling Street,
Manston,
Ramsgate,
Kent.

In correspondence and discussions with both readers and retailers it has become apparent to us that there is an element of misunderstanding, mistrust and possibly dissatisfaction with mail order buying. To promote a better understanding between all concerned we propose to investigate the whole area and publish a feature explaining the problems and the legal rights involved.

With this in mind we would like to hear from you with your views and ideas on this subject. Unfortunately we cannot undertake to answer all letters but expect to be able to give a representative readers view in the forthcoming article.

Mike Kenward,
Editor.



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SECURITY SENTRY

WILLIAM DICKINSON

THIS compact and totally self contained security system should prevent your caravan and its contents from becoming another police statistic and may prevent your well-earned holiday from being ruined by thieves or vandals. Although this system was designed to protect caravans it will work equally well in protecting garden sheds, garages, small houses, cottages and flats.

FEATURES

Several unique features incorporated into the design of the alarm control centre provides comprehensive protection against removal or entry by unauthorised persons. Special attention to quiescent current demands and the use of CMOS integrated circuits in the design ensure maximum life of the internal batteries.

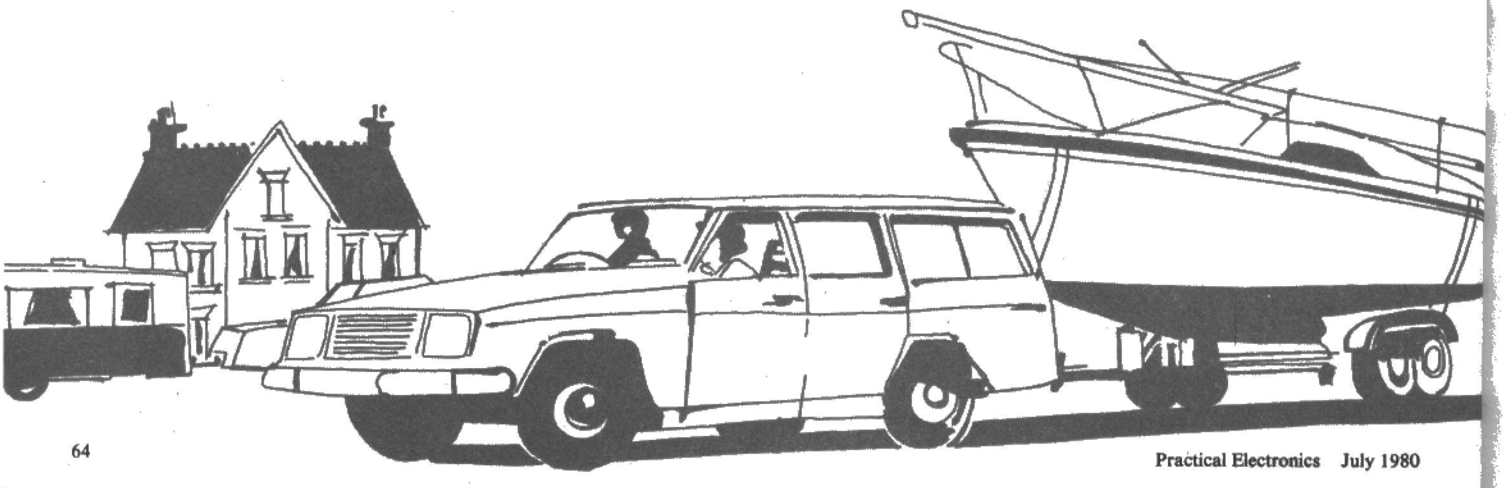
A battery test is provided via a light emitting diode. Whenever the system is activated the l.e.d will momentarily illuminate, indicating that the batteries are in good condition. As the quiescent current of the alarm system is less than 40 microamperes, the four MN1400 alkaline batteries can be expected to last well over a year in normal service.

The break-in protection of the alarm system provides exit and entry delays before the siren is triggered so there is no need to fit an external lock switch to the caravan. When leaving the alarm switch on the concealed alarm control centre is placed in the "Activate" position whereupon the owner has one and a half minutes to leave the caravan. Upon re-entry an alarm latch is triggered the moment the door is opened. However, a thirty second delay is provided to give the owner time to place the alarm switch in the "Defeat" position before the siren is triggered. If the alarm switch is not placed in this position within thirty seconds the siren will begin to sound and continue to sound for two and a half minutes before automatically resetting. However, in the initial cause of the alarm is still present, the siren will retrigger. This will continue until the source of alarm activation has been removed or the alarm switch is cycled through the battery test function and then returned to the "Defeat" position. Cycling through the battery test function to silence the alarm, i.e. moving the alarm switch from "Activate" to "Defeat" twice, has been done intentionally in order to confuse any unauthorised person who may be tampering with the system in an effort to silence the siren.

Tow-away protection is provided by a self-activating section of the alarm system which operates completely independently of the break-in protection section and the position of the alarm switch. No would-be thief is likely to risk attracting the attention of the police by driving down the road without the brake and turn signal lights on the caravan in operation. Therefore he will, in all likelihood, connect the caravan's seven pin lighting plug to his vehicle before attempting to tow it away. A seven pin socket which mates with the caravan's plug is employed to detect tampering with the plug contacts and also provides a convenient place to stow it when it is not in use, thereby protecting it from the elements. Additional protection is provided by leaving the caravan's levelling jack down and looping the cable leading to the plug around the levelling crank before inserting it into the sensing socket. When the plug is inserted into the sensing socket the alarm will automatically activate itself in three minutes.

If the plug is removed (or the cable cut) after the arming interval has elapsed, the siren will sound immediately and will continue to sound until manually reset by the alarm switch. If the plug is re-inserted into the sensing socket after the siren begins to sound the siren will continue to sound for one and a half minutes before automatically silencing itself. The alarm will then return to the activated state and continue to monitor the status of the plug.

Whenever the owner has to remove the plug the alarm switch is cycled through the battery test function. This will inhibit the alarm sensing action of the sensing socket for three minutes, ample time to remove the plug without initiating the alarm sequence.



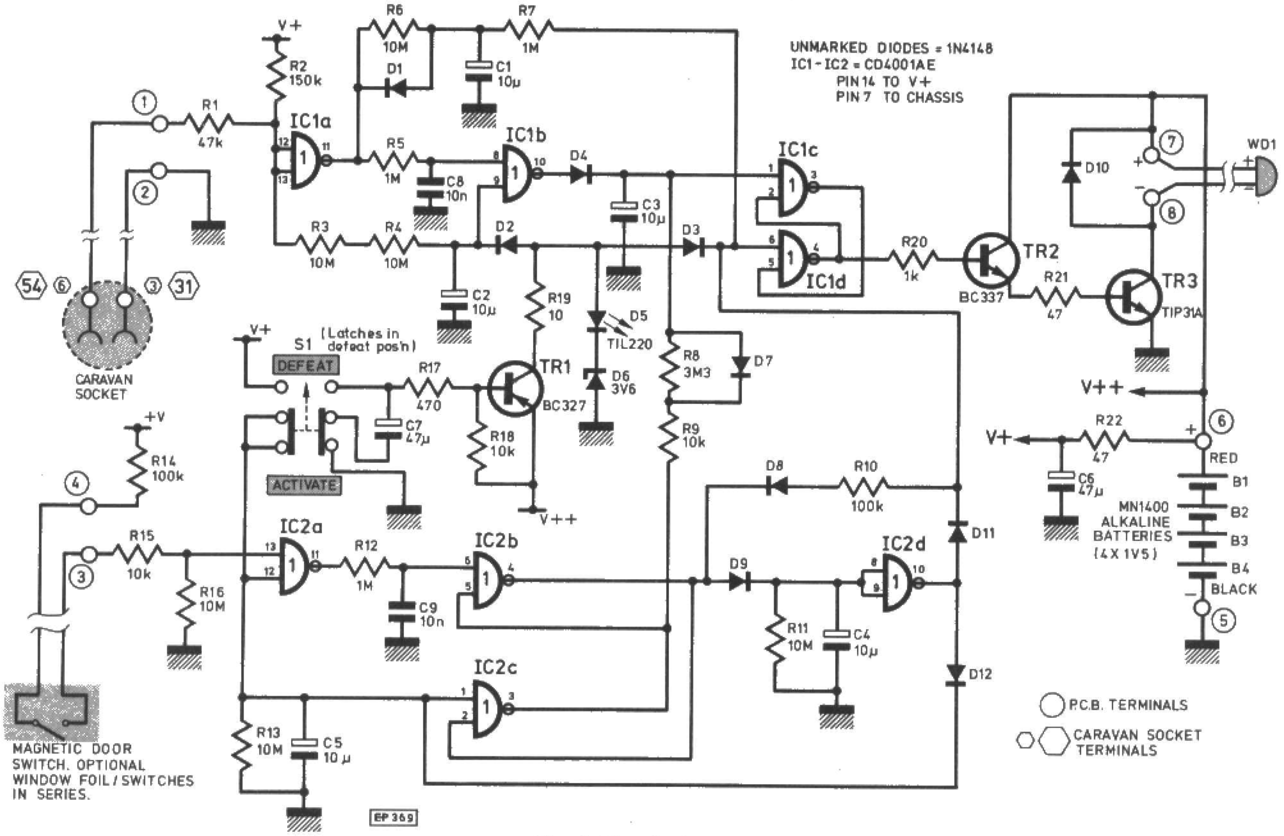


Fig. 1 Circuit diagram

POWER SUPPLY

Power is supplied by four MN1400 alkaline batteries, B1 through B4. The quiescent current of the system is primarily determined by R1 and R2, and to a lesser degree on R14, R15 and R16 as the integrated circuits draw negligible current. The battery supply is split into two sections, V++ and V+. The V++ section supplies the high current demands of the siren at terminal (7) and battery test secton. The V+ supply is decoupled from the noise and spikes present on the V++ supply via R22 and C6 and supplies the alarm logic.

BATTERY TEST

Assume that S1 is in the "Defeat" position and is moved to the "Activate" position. C7, which was previously shunted by S1 and therefore completely discharged, will rapidly charge through R17, R18 and the base-emitter junction of TR1. This will momentarily forward bias it developing a 6 volt pulse at the collector which overcomes the 3·6 volt barrier potential of D6 leaving 2·4 volts to illuminate D5. D6 will always require 3·6 volts to overcome the barrier potential, therefore as the battery voltage drops the voltage available to D5 will drop. When the battery potential is approximately 4 volts it will no longer illuminate when S1 is cycled, indicating that the batteries should be replaced.

RESET

The 6V pulse produced at the collector of TR3 when S1 is moved from the "Defeat" to "Activate" position is connected to the junction of steering diodes D2 and D3 appearing at pin 6 of IC1d via D3 and will reset the siren latch flip-flop at a safe condition. The reset pulse steered through D2 will be discussed in the tow-away protection system.

SIREN LATCH AND DRIVER

IC1c and IC1d are cross-coupled to form a set-reset flip-flop. A logic '1' at pin 1 of IC1c is an alarm condition. A logic '1' at pin 6 of IC1d is used to reset the flip-flop to 'safe' condition.

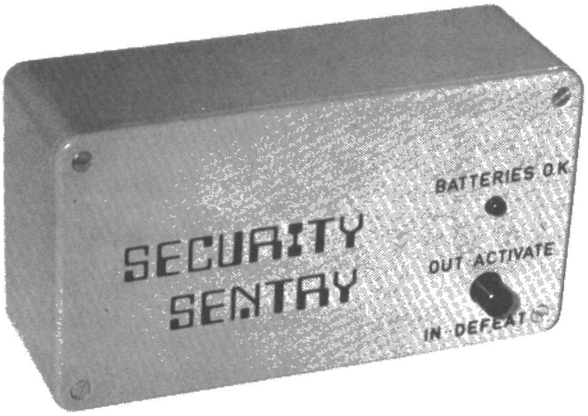
When an alarm condition is sensed by IC1c the siren latch flip-flop will lock with a logic '1' at pin 4 of IC1d. The flip-flop will remain locked in this state until a reset pulse is presented to pin 6 of IC1d. Pin 4 of IC1d drives a modified Darlington pair consisting of R20. TR2 R21 and TR3 into conduction providing an earth return for the siren at terminal (8). This configuration exhibits a very low saturation voltage across TR3 when it is conducting which minimises power losses. Diode D10 absorbs the spikes created by the siren

BREAK-IN PROTECTION

Break-in protection is provided by a closed loop consisting of a magnetic door switch and optional window foil/magnetic switches protecting access points to the caravan.

Assume that S1 is in the "Defeat" position. This will fully charge C5 and place a logic '1' at the inputs of IC2a and IC2c. IC2b and IC2c are cross-coupled to form an alarm latch flip-flop. A logic '1' at the input of IC2a and IC2c will lock the flip-flop to the safe condition with a logic '0' at the output of IC2c and inhibit IC2a so ignoring the status of the alarm sensing input.

When S1 is moved to the "Activate" position C5 will begin to discharge through R13. In approximately $1\frac{1}{2}$ minutes (exit delay) a logic '0' will be present at IC2a and IC2c enabling this section of the alarm. The alarm sensing input of IC2a (pin 13) is normally held at logic '1' via R14, the closed magnetic switch loop and R15.



Fascia and legending

ALARM SEQUENCE

When the closed alarm loop is broken R16 will pull the alarm sensing input down to logic 'O'. With both inputs of IC1a at logic 'O' a logic '1' is produced at its output. This logic '1' is coupled to the alarm input of IC2b and IC2c via a transient suppression network consisting of R12 and C13. The alarm latch flip-flop will reverse states and will have a logic '1' at the output of IC2c and a logic 'O' at the output of IC2b. The logic '1' at the output of IC2c will begin to charge C3 via R8 and R9 in approximately 30 seconds (the entry delay) C3 will be charged to a logic '1' which will cause the flip-flop to lock to the alarm condition and sound the siren. The logic 'O' at the output of IC2b will pull down the input of IC1d via D6 and R10 so that any 'safe' condition status presented by the tow away section of the alarm (via R7) will be ignored.

If the owner places S1 in the "Defeat" position within the thirty second entry delay period the alarm sequence will be pre-empted and the alarm latch will return to a safe condition.

AUTO AND MANUAL RESET

Prior to switching into the alarm state C4 is charged to a logic '1' via blocking diode D9. Once in the alarm state C4 will begin to discharge through R11. In approximately 2½ minutes C4 will have discharged sufficiently to present a logic 'O' at the input of IC2d. This is inverted to a logic '1' and presented to the junction of steering diodes D11 and D12. D11 steers a logic '1' reset pulse to IC1d resetting it to a safe condition silencing the siren. D9 steers a logic '1' to the inputs of IC2a and IC2c which resets the alarm latch flip-flop to a safe condition. This places a logic '1' at the output of IC2b which charges C4 back to logic '1' thereby changing the output of IC2d back to logic 'O'. The logic 'O' at the output of IC2d rapidly discharges C3 via D7 and R9. At this point the alarm system is completely reset to the safe condition and C5 once again begins to discharge through R13. Momentarily the system will re-activate itself and will react to whatever the status of the closed loop is at the moment e.g. if the loop is closed, the alarm will remain silent; if the loop is still open, the alarm sequence will repeat indefinitely.

To defeat the alarm sequence once it has been initiated S1 is cycled through the battery test function and returned to the "Defeat" position. This places a logic '1' at the input of IC2a, inhibiting the alarm sensing input and the input of IC2c locking the alarm latch flip-flop to the safe condition. The siren latch will also be reset to the safe condition by the pulse produced by the battery test circuit.

CARAVAN TOW-AWAY PROTECTION

If the unit is to be used in a domestic application this section should not be used. D1, D2, D4, C1, C2, C8 and R1 can be omitted. R2, R3, R4, R6 and R7 must be retained to pull-up IC1a, IC1b and IC1d.

IC1a, IC1b and associated components form an automatic activating and self-resetting circuit which detects tampering with the seven pin caravan plug. A seven pin socket, SK1 is employed as a sensing device. This section of the alarm operates completely independently of the "Activate/Defeat" switch.

OPERATION

Assume that the alarm control is defeated and you have just parked your caravan. C2 will be fully charged through R2, R3 and R4, presenting a logic '1' to pin 9 of IC1b which will inhibit the alarm sensing input at pin 8. The output of

COMPONENTS

Resistors

R1	47k
R2	150k
R3	10M
R4	10M
R5	1M
R6	10M
R7	1M
R8	3·3M
R9	10k
R10	100k
R11	10M
R12	1M
R13	10M
R14	100k
R15	10k
R16	10M
R17	470
R18	10k
R19	10
R20	1k
R21	47
R22	47

All ¼W 10% carbon film

Capacitors

C1–5	10u	6·3V	Tant
C6	47u	6·3V	Tant.
C7	47u	6·3V	Tant.
C8	10n	50V	ceramic
C9	10n	50V	ceramic

Semiconductors

IC1	4001AE
IC2	4001AE
TR1	BC327
TR2	BC337
TR3	TIP31A
D1–4	1N4148
D5	TIL220 0·2in red l.e.d.
D6	3·6V Zener (BZY88C3V6)
D7–12	1N4148

Switches

S1	2 pole changeover push-button

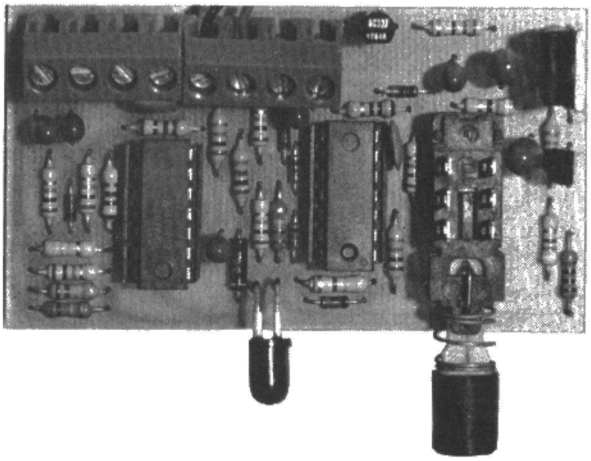
Miscellaneous

2–4 way p.c. connectors, p.c.b. 42 × 76 mm, 2–14 pin sockets, B1–4—4MN1400 1½V alkaline batteries, seven caravan socket with dust cover, magnetic door switch.

Control Centre available from **Compu-Tech Systems, Gaymers Way, Laundry Loke Industrial Estate, North Walsham, Norfolk.**

IC1b will be a logic 'O' which is a safe condition. The input of IC1a will be pulled up to a logic '1' by R2. IC1a inverts this to a logic 'O' and couples it to IC1b via a transient absorbing network consisting of R5 and C8. This logic 'O', which represents an alarm condition, will be inhibited be the logic '1' present at pin 9. The same conditions would be present if the alarm control centre was activated.

When the caravan's 7 pin plug is inserted into its socket, the circuit is closed between terminals (1) and (2) via the brake light circuit of the caravan. This presents a logic 'O' at the input of IC1a and begins to discharge C2 through R1, R3 and R4. A 3 : 1 ratio between R1 and R2 has been selected to help minimise the effects of moisture in the 7 pin socket and reduce quiescent battery current. Whenever the 7 pin plug is inserted the input of IC1a will be approximately 1·4v which is slightly below the minimum threshold for logic'O'. The logic 'O' at the input of IC1a is inverted to a logic '1' which is passed to IC1b as a safe condition. In approximately 3 minutes C2 will be discharged sufficiently to present a logic 'O' to pin 9 of IC1b which enables the gate to pass an alarm condition if detected.



If, at any point past the 3 minute 'activate delay' the 7 pin connector plug is removed by an unauthorised person, input of IC1a is pulled up to logic '1' by R2, IC1a inverts this and presents a logic 'O' to pin 8 of IC1b. C1 is discharged immediately into IC1a via D1. IC1b now has logic 'O' at both inputs resulting in a logic '1' at its output. This logic '1' is coupled to the 'alarm' input of the set-reset flip-flop via D4 charging C3 to V+ in the process. The logic '1' at the input of the siren latch flip-flop locks it to the alarm state and activates the siren. The siren will run until the system is manually reset or until the caravan's 7 pin plug is reinserted.

When the 7 pin plug is removed the resistance across pins 3 (31) and 6 (54), caravan socket numbers in parentheses, must exceed 300,000 ohms for proper circuit operation. Liberal application of petroleum jelly to the exposed connections on the socket will ensure that this condition is met under adverse weather conditions and in saliferous environments.

AUTO AND MANUAL RESET

When the caravan's seven pin plug is reinserted the input of IC1a will be pulled down to a logic 'O' which is inverted by IC1d and presents a logic '1' at the output which begins to charge C1 via R6. After approximately 1½ minutes C1 will be charged sufficiently to present a logic '1' to IC1d via R7 which will reset the siren latch flip-flop to a safe condition.

When the caravan plug must be removed, S1 is cycled through the battery test function. The six volt reset pulse

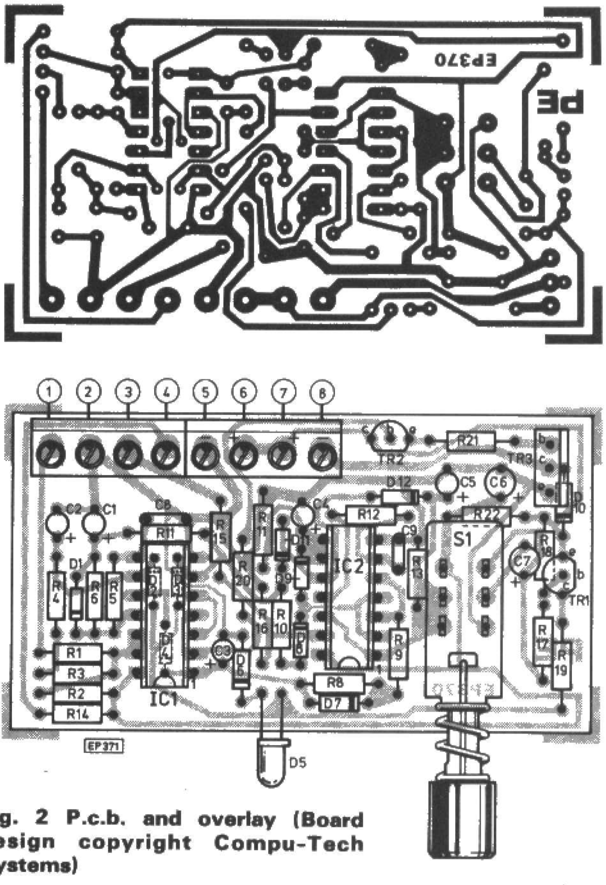


Fig. 2 P.c.b. and overlay (Board design copyright Compu-Tech Systems)

produced at the junction of the steering diodes D2 and D3 when the l.e.d. illuminates will charge C2 to a logic '1' via D2. This will inhibit the alarm sensing action for approximately 3 minutes, ample time to disconnect the caravan plug without activating the alarm.

All of the time delays given are nominal and are dependent on the combined tolerances of the timing resistors and capacitors, the logic thresholds of the integrated circuits, and to a lesser degree, on the battery potential. The time delays given in the text can be expected to vary ± 30% from the figures given. The time delays given in the text can be adjusted to suit your individual requirements by increasing or decreasing the values of the resistors or capacitors tabulated below in direct proportion to the change in time desired.

Break-in Protection	
Exit Delay	R13 and C5
Entry Delay	R8 and C3
Reset Delay	R11 and C4
Tow-away Protection	
Activate Delay	R3, R4 and C2
Reset Delay	R6 and C1

CONSTRUCTION

Construction is generally straightforward. The battery holder is glued to the case first. The printed circuit board is then assembled, noting that diodes D2, D3 and D4 are mounted underneath the socket for IC1. The unit is then mounted in the selected location. The siren, seven pin sensing socket, and magnetic door switch are then installed and the wires routed back to the alarm control centre. These wires along with the two battery wires are then connected to the p.c. screw terminals provided. Once the batteries are installed the system can be tested and put into service.

★

MICRO PROMPT

The hardware and software exchange point for PE computer projects

GOOD GAME! GOOD GAME!

This game, in Compukit BASIC, was briefly reviewed in the last issue of Practical Electronics, along with other programs by the same author. As promised, the full listing appears below. Note that the stars represent multiplication signs (i.e. asterisks).

```
1    REM "LE PASSE-TEMPS" A. KNIGHT 15/12/79
25   ?"1) The object of the game is to get FOUR"
26   ? "IN A LINE"
28   ?"2) The board is a 6 by 7 matrix, and a line"
29   ?"may be horizontal, vertical or diagonal."
30   ?"3) Columns are filled from the base upward."
32   ?"4) In play, only three keys are used:" : ?
33   ?" a) Shift left moves the pointer left."
34   ?" b) Shift right....."
35   ?" c) The space bar drops your marker to the"
36   ?" foot of the selected column"
40   DIM$(44), T(11) : POKE530, 1 : ? : GOT060
50   FOR I = 1 TO 4000: NEXT
60   M$ = "HIT 'Z' TO CONTINUE" : GOSUB970
70   Q = 57088 : POKEQ, 253: IF PEEK(Q)> <223 THEN 70
80   E = 0 : F = O : G = 0: FOR A = 1 TO 42 : S(A) = 0 : NEXT
90   ?TAB(16)" LE PASS-TEMPS" : ? : ?
91   ? : ?TAB(7) "SCORES" : ? : ?
92   ?"YOU"; TAB(9)S1
93   ? : ?"ME"; TAB(9)S2 : ?
94   ?"DRAWN"; TAB(9)S3 : ? : ? : ?
95   RESTORE
100  L = 53338 : DATA 136, 143, 209, 208
110  FOR T = 1 TO 13 : IF T/2 = INT(T/2) THEN RESTORE
120  READ A, B : FOR C = 1 TO 28 STEP 4
125  IF T = 1 THEN 140
126  POKEL, 143 : POKEL+29, 136
130  POKEL+C, A : POKEL+C+3, B
140  NEXT C : L = L+64 : NEXT T
150  N = 36 : FOR C = 1 TO 7 : N(C) = N : N = N+1 : NEXT
160  R = 53336 : C = 4
170  S = S1+S2+S3 : IF S/2 < > INT(S/2) THEN 495
200  M$ = "MY MOVE" : GOSUB950
205  V = 0 : X = 0 : Y = 0 : Z = 0
210  FOR J = 1 TO 7 : C = C + 1 : IF C > 7 THEN C = 1
220  P = R+C★4 : IF N(C) > 0 THEN GOSUB 700
230  IF F THEN 450
240  NEXT
250  IF X THEN C = X : GOTO450
260  IF Y THEN C = Y : GOTO330
270  IF Z THEN C = Z : GOTO330
310  C = INT(RND(1)★7+1) : IF N(C)<1 THEN 310
320  V = V+1 : IF C < > 4 AND V<5 THEN 310
330  IF N(C) < 8 THEN F = 0 : GOTO450
340  IF V<10 THEN 400
350  IF V/3 = INT(V/3) THEN MM = 1 : M$ = "NOW WHAT DO I DO?" : GOSUB970
360  IF V<21 THEN 400
370  FOR A=1 TO 500 : Q = INT(RND(1)★940+53260)
380  J = INT(RND(1)★256) : POKEQ, J
390  NEXT : E = 1 : GOTO640
400  N(C) = N(C)–7 : Z = 0 : GOSUB700 : N(C)=N(C) + 7
410  IF F THEN F = 0 : IF V<9 THEN 310
420  IF Z THEN Z=0 : IF V<6 THEN 310
430  IF X THEN X = 0 : GOTO310
450  X = R+63+C ★ 4+128 ★ (N(C)–C) /7
470  FOR B = 1 TO 2 : POKE X+B, 154 : POKE X+B+64, 155: NEXT
480  S(N(C)) = 5 : N(C) = N(C)–7
490  IF F THEN M$ = "I WIN!" : GOSUB970 : S2 = S2+1 : GOTO50
495  M$ = "YOUR MOVE" : GOSUB950
500  P = R+C★4 : POKEP,31 : POKEP+1,31 : POKE530,1
510  POKEQ,254 : IF T = 251 THEN T = 253 : GOTO520
515  T = 251
516  IF PEEK(Q) = 254 THEN MM = 1 : M$ = "RELEASE SHIFT LOCK" : GOSUB970 : GOTO495
520  IF PEEK(Q) = T THEN 550
530  POKEQ,253 : IF PEEK(Q) = 239 THEN 600
540  GOTO510
550  IF T = 253 AND C < 7 THEN C = C+1
560  IF T = 251 AND C>1 THEN C = C–1
570  POKEP,32 : POKEP+1,32
580  GOTO500
600  L = (N(C)–C)/7 : IF L<0 THEN 500
610  X = P+63+L★128
620  FOR A = 1 TO 2 : POKE X+A, 193 : POKE X+A+64,191 : NEXT A
630  S(N(C)) = 1 : E = 0 : GOSUB700
640  IF E THEN M$ = "YOU WIN!" : GOSUB950 : S1 = S1+1 : GOTO50
650  N(C) = N(C)–7 : GOTO200
700  P = R+C★4 : POKEP,31 : POKEP+1,31
705  FOR A = 0 TO 11 : T(A) = O : NEXT A
710  I = 0 : M = N(C)
720  FOR U = M TO M+21 STEP7 : IF U> 42 THEN 740
730  T(I) = T(1)+S(U)
740  NEXTU : I = I+1
750  FOR A = C–3 TO C+3 : IF A<1 THEN A = 1
760  IF A>4 OR A>C THEN 800
770  FOR B = A TO A + 3 : T(I) = T(I)+S(M–C+B) : NEXT B : I = I+1
780  N = M–(C-A)★8 : IF N<1 OR N> 18 THEN 800
790  FOR D = 0 TO 3 : T(I) = T(I)+S(N) : N = N+8 : NEXT D : I = I+1
800  IF A>7 THEN 840
810  IF A<4 OR A<C THEN 840
820  N = M+(C-A)★6 : IF N<4 OR N> 21 THEN 840
830  FOR D = 0 TO 3 : T(I) + T(I) + S(N): N = N+6 : NEXT D : I = I+1
840  NEXT A
850  FOR H = O TO I : D = T(H) : IF D = 4 THEN E = 1
860  IF D = 15 THEN F = C
870  IF D = 10 THEN Z = C
880  IF D = 3 THEN X = C
890  IF H AND D = 2 THEN Y = C
900  NEXT H
910  POKEP,32 : POKEP+1,32
920  RETURN
950  FOR A = 1 TO 7 : IF S(A) = O THEN 970
960  NEXT A : M$ = "IT'S A DRAW" : G = 1
970  ?TAB(47); CHR$(13);
980  ?TAB (22–LEN (M$)/2) M$; CHR$(13);
1010 IF MM = O THEN 1040
1020 FOR D = 1 TO 600 : NEXT : MM = 0 : M$ = "": GOTO970
1040 POKE54220,32
1070 IF G THEN G = O : S3 = S3+1 : GOTO50
1080 RETURN
```

101 SCREEN EDITOR

A screen editor has been sent in by *N. A. Climpson,* which to use is simplicity itself. Loading this software is easy too, for machine code is transported into the Compukit's memory by a self-destructing BASIC program.

The program occupies 324 bytes of RAM, two zero page addresses 00F9 and 00FA and five addresses, 02F6–02FA in an area of RAM not used by BASIC. It is located for the 8K machine at memory locations 7865 to 8189 (decimal) so that it can be protected from BASIC. A response of 7850 to MEMORY SIZE? on a cold start is satisfactory.

```
50000 REM ***** UK101 SCREEN EDITOR ********
50002 REM *****  by Nigel Climpson ********
50004 REM *****        1980        ********
50006 DATA 152,72,172,249,2,173,248,2,145,249
50008 DATA 136,206,249,2,32,244,31,104,168,169
50010 DATA 0,96,76,185,30,152,72,32,214,31
50012 DATA 172,249,2,169,35,145,249,238,249,2
50014 DATA 208,2,230,250,200,32,244,31,104,168
50016 DATA 169,0,96,202,16,4,232,76,153,163
50018 DATA 138,72,152,72,172,249,2,174,0,2
50020 DATA 173,250,2,240,5,173,248,2,145,249
50022 DATA 169,32,157,0,211,202,136,206,249,2
50024 DATA 206,0,2,169,95,157,0,211,206,246
50026 DATA 2,173,250,2,240,3,32,244,31,104
50028 DATA 168,104,170,169,0,96,32,186,255,201
50030 DATA 21,240,26,201,28,240,182,201,4,240
50032 DATA 150,201,2,240,143,201,6,240,111,201
50034 DATA 13,240,80,32,214,31,76,153,163,56
50036 DATA 152,72,173,250,2,240,8,172,249,2
50038 DATA 173,248,2,145,249,238,250,2,173,250
50040 DATA 2,201,16,240,31,201,1,208,6,173
50042 DATA 0,2,141,249,2,173,249,2,233,64
50044 DATA 176,2,198,250,141,249,2,168,32,244
50046 DATA 31,104,168,169,0,96,169,0,141,250
50048 DATA 2,169,211,133,250,173,0,2,141,249
50050 DATA 2,208,230,169,0,141,250,2,133,249
50052 DATA 169,211,133,250,169,32,141,248,2,169
50054 DATA 204,141,246,2,141,249,2,169,13,96
50056 DATA 152,72,32,214,31,173,248,2,172,249
50058 DATA 2,145,249,141,247,2,200,238,249,2
50060 DATA 208,2,230,250,32,244,31,104,168,173
50062 DATA 247,2,76,153,163,72,173,0,2,205
50064 DATA 246,2,16,13,56,173,249,2,233,64
50066 DATA 176,2,198,250,141,249,2,173,0,2
50068 DATA 141,246,2,104,96,177,249,141,248,2
50070 DATA 169,95,145,249,96
50072 FOR I= 7865 TO 8189:READ A:POKE I,A:NEXT
50074 POKE 536,45:POKE 537,31
50076 NEW
```

Key memory locations for editor program in an 8K Compukit.

00F9	Low byte of V.D.U. RAM address
00FA	High byte of V.D.U. RAM address
02F6	Input cursor position temporary
02F7	Character temporary
02F8	stores
02F9	Edit cursor horizontal position
02FA	Edit cursor vertical position
1F2D–1F4D	Editor entry and key pressed detection
1EB9–1ED1	Control B routine
1ED2–1EED	Control D routine
1EEE–1F2C	Rubout routine
1F4E–1F96	Control U routine
1F87–1F97	Handles edit cursor over top line
1F98–1FB2	Return routine. Initialises stores
1FB3–1FD5	Control F routine
1FD6–1FF3	Subroutine senses scroll up and repositions edit cursor one line up
1FF4–1FFD	Subroutine for saving character about to be sat on by edit cursor and substituting cursor character
1F64	Number of scrolling lines on screen

The functions are accessed through the use of Rubout, and the control key plus U, D, F and B.

Control U moves the edit cursor up
Control F copies forward
Control B moves the edit cursor backwards
Control D deletes on the edit line
Rubout True backspace

The line to be altered is displayed anywhere on the screen using LIST.

With Control U an Edit Cursor separates from the Input Cursor and moves vertically up the screen. (If it goes off the top it reappears at the bottom.)

The Edit Cursor is stopped at the selected line and moved forward with Control F. Each character the Edit cursor moves past on the old line is copied by the Input cursor on a new line *at the bottom on the screen.* The auto repeat facility can be used. Return *at any stage* enters the new line displayed at the bottom of the screen.

Extra characters are inserted into the new line by halting the Edit Cursor at the appropriate position and entering characters through the keyboard. Resumption of Control F copies the rest of the old line to the new one at the bottom of the screen.

Deletions can be made at any point by pressing Control D which displays a # for each deleted character on the old (Edit) line and gives no input on the new (Input) line.

Changing of characters is accomplished by copying forward to the "correction" point, entering new characters through the keyboard, typing Control D over the unwanted characters on the Edit line and continuing to copy forward over the remainder.

Use of Control B allows movement of the Edit Cursor to the left without moving the Input Cursor. This feature is incredibly useful, allowing you to repeat phrases on a line, or, in conjunction with Control U, move the Edit Cursor around the screen to pick out phrases listed elsewhere and make a new composite line. One use of this function is in the condensation of programs, since several single BASIC statements can be brought together on one line with ease.

This editing facility cannot be used to alter the Input Line; only a previously entered program line.

On long statements which run to a second line, the Edit Cursor needs typically sixteen Control Ds to carry it over the undisplayed part of the video memory if blanks are to be avoided on the Input Line. Also, on two-line statements, Rubout should not be used to retreat from the second line to the first.

The program listed here should be loaded and RUN, to shift the machine code into memory. It is probable that you will not require the services of the Editor immediately, in which case RETURN will have been pressed during programming; but if the Editor is required immediately after loading, it is necessary to press Return to initialise certain memory locations.

The Editor is a compromise between versatility and memory consumption, but will nevertheless be most useful to 101 users.

Modifications for 4K Compukit

Line No.	Old	New
50008	31	15
50010	30	14
50010	31	15
50014	31	15
50026	31	15
50034	31	15
50046	31	15
50056	31	15
50060	31	15
50072	7865	3769
50072	8189	4093
50074	31	15

Modifications for 8K Superboard

Line No.	Old	New
50030	28	95 (For shift 0 as backspace)
50040	16	Number of lines that can be scrolled and seen on screen
50042	64	32
50054	204	101
50064	64	32

The Editor will still be present in RAM after a Reset and Warm Start, but it must be *reactivated* by the POKE statements in line 50074 of the BASIC listing.

Warning: These two POKES must be executed simultaneously on the same instruction line or the machine will lock-up.

EDITOR DISASSEMBLED

```
1EB9 98     TYA
1EBA 48     PHA
1EBB ACF902 LDY $02F9
1EBE ADF802 LDA $02F8
1EC1 91F9   STA ($F9),Y
1EC3 88     DEY
1EC4 CEF902 DEC $02F9
1EC7 20F41F JSR $1FF4
1ECA 68     PLA
1ECB A8     TAY
1ECC A900   LDA #$00
1ECE 60     RTS
1ECF 4CB91E JMP $1EB9
1ED2 98     TYA
1ED3 48     PHA
1ED4 20D61F JSR $1FD6
1ED7 ACF902 LDY $02F9
1EDA A923   LDA #$23
1EDC 91F9   STA ($F9),Y
1EDE EEF902 INC $02F9
1EE1 D002   BNE $1EE5
1EE3 E6FA   INC $FA
1EE5 C8     INY
1EE6 20F41F JSR $1FF4
1EE9 68     PLA
1EEA A8     TAY
1EEB A900   LDA #$00
1EED 60     RTS
1EEE CA     DEX
1EEF 1004   BPL $1EF5
1EF1 E8     INX
1EF2 4C99A3 JMP $A399
1EF5 8A     TXA
1EF6 48     PHA
1EF7 98     TYA
1EF8 48     PHA
1EF9 ACF902 LDY $02F9
1EFC AE0002 LDX $0200
1EFF ADFA02 LDA $02FA
1F02 F005   BEQ $1F09
1F04 ADF802 LDA $02F8
1F07 91F9   STA ($F9),Y
1F09 A920   LDA #$20
1F0B 9D00D3 STA $D300,X
1F0E CA     DEX
1F0F 88     DEY
1F10 CEF902 DEC $02F9
1F13 CE0002 DEC $0200
1F16 A95F   LDA #$5F
1F18 9D00D3 STA $D300,X
1F1B CEF602 DEC $02F6
1F1E ADFA02 LDA $02FA
1F21 F003   BEQ $1F26
1F23 20F41F JSR $1FF4
1F26 68     PLA
1F27 A8     TAY
1F28 68     PLA
1F29 AA     TAX
1F2A A900   LDA #$00
1F2C 60     RTS
1F2D 20BAFF JSR $FFBA
1F30 C915   CMP #$15
1F32 F01A   BEQ $1F4E
1F34 C91C   CMP #$1C
1F36 F0B6   BEQ $1EEE
1F38 C904   CMP #$04
1F3A F096   BEQ $1ED2
1F3C C902   CMP #$02
1F3E F08F   BEQ $1ECF
1F40 C906   CMP #$06
1F42 F06F   BEQ $1FB3
1F44 C90D   CMP #$0D
1F46 F050   BEQ $1F98
1F48 20D61F JSR $1FD6
1F4B 4C99A3 JMP $A399
1F4E 38     SEC
1F4F 98     TYA
1F50 48     PHA
1F51 ADFA02 LDA $02FA
1F54 F008   BEQ $1F5E
1F56 ACF902 LDY $02F9
1F59 ADF802 LDA $02F8
1F5C 91F9   STA ($F9),Y
1F5E EEFA02 INC $02FA
```

PEVDU SOFTWARE?

Sir—I have recently built the PE VDU, with which I am most pleased.

Could you suggest where I might obtain suitable operating software to drive the VDU and full keyboard. The micro I am using is the issue 2 MK14 with new monitor.

Also, can you suggest how I might remove the scan lines from my screen (only apparent when VDU board is connected to TV set). I am going in direct video.

N. F. Harris
Burton-on-Trent

101 TRICK

Here is a tip sent in by *J. D. Owen* of Dyfed.

100 PRINT CHR$ (13); TAB(48)CHR$ (13);

110 PRINT (new information);

Line 100 clears the bottom line of the VDU before line 110 reprints new information. This prevents the previous information from scrolling up the screen.

A similar trick is to replace line 100 with:

POKE 512, 205

TV TEASER

Sir—I own a UK101 and wish to display 64 characters per line. In your articles on the UK101 you say that this may be achieved by getting the TV to underscan, but you also say that the software is arranged to limit the line length to 48 characters to prevent loss of information. How is it possible to alter this—would a machine code routine work, or some "POKEs", or would the ROMs need rewriting?

I would be very grateful if someone could answer this problem as I feel that 64 columns would be very useful.

T. D. Allen
Poole.

Has anyone actually done this?

TELEWRITING

Sir—In the January 'Readout' column, Mr. J. W. Coulthard asks if it is possible to use the COMPUKIT UK101 keyboard in immediate mode without getting "?SN ERROR" on every line. The following program, which makes use of a machine code sub-routine given in the Manual, will allow the keyboard to be used to write messages on the screen, or to work a Printer as a Typewriter:

```
200   POKE 11, 237 : POKE 12, 254
210   X=USR (X) : A=PEEK (531)
220   IF A=13 THEN PRINT CHR$ (10);
230   PRINT CHR$ (A);
240   GOTO 210
```

This program could easily be modified (by changing line 230) to produce graphics characters and enable pictures to be drawn.

A modified form of this program was used to produce this letter using my COMPUKIT and a Printer.

G. L. Steer,
Ewell,
Surrey.

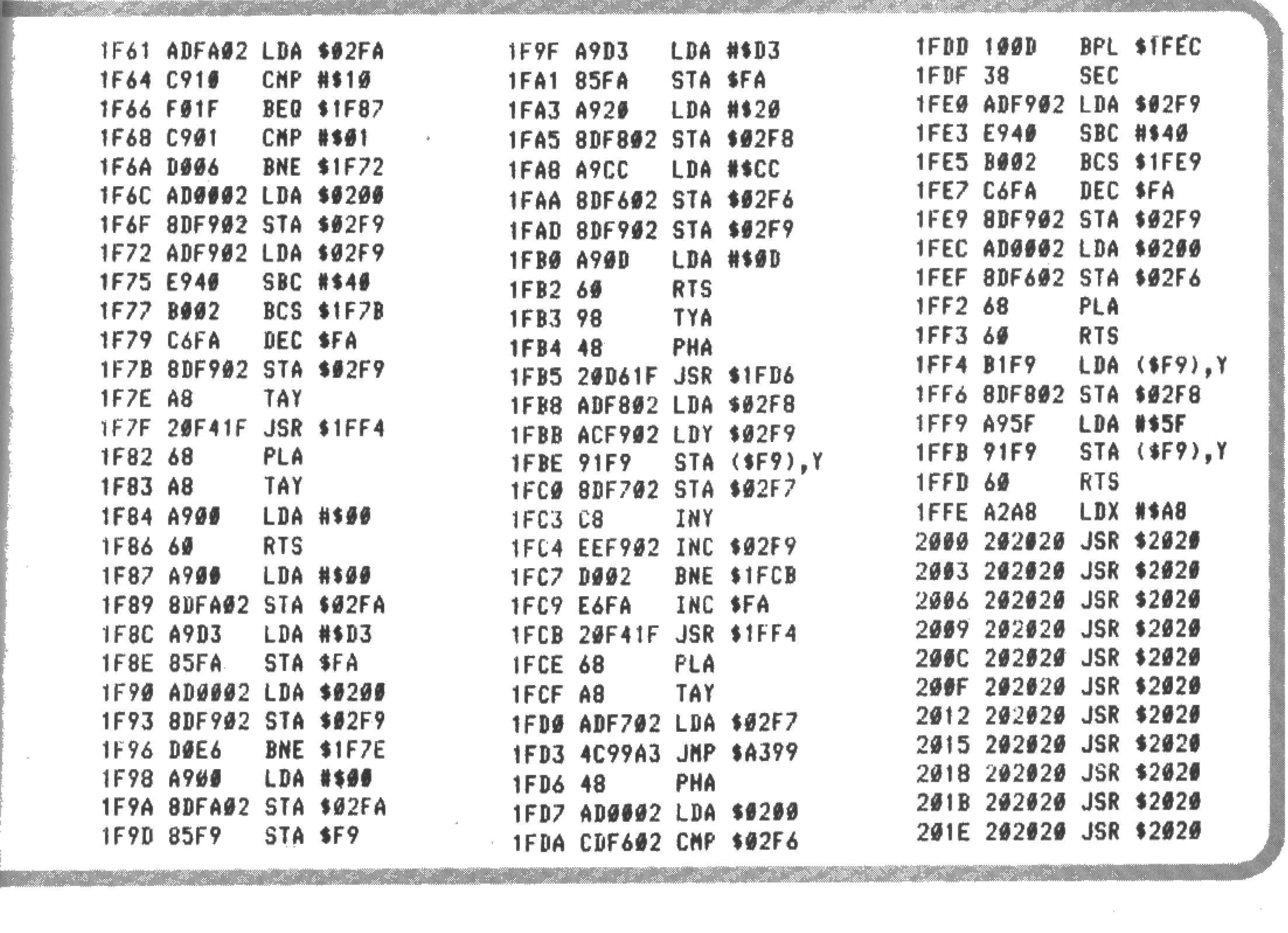
HOLD THAT VARIABLE!

Debugging a program which, for instance, starts with a series of input statements, can be laborious. Each time an unsuccessfully run program is listed and subsequently edited, all variables are lost, and on re-running, one has to input all the data again. Only if the program text has not been altered is it possible to re-run a program without loss of variables by using the GOTO statement in Command Mode.

A program to maintain all the variables throughout that inevitable debugging phase has been written by *Richard Hocking* of Wellingborough.

When a new line is inserted into the program, the Text End Pointer (and program text) are moved down, but the Variable and Array Store are not copied down. The Variable and Array End Pointers are then reset (to the same as the Text End Pointer), to ensure that it is not possible to recall a variable which has been overwritten when the text was copied down.

This program overcomes the problem by modifying the input routine as follows. Firstly the Text End Pointer is set equal to the Array End Pointer. Then, when a new line is inserted, everything up to the Array End Pointer is copied down by the correct amount, and the new line is inserted in its correct place. Thus the variable and array information is preserved without corruption. Then if the pointers for the text, variables, arrays and strings are reset to



```
1F61 ADFA02 LDA $02FA
1F64 C910   CMP #$10
1F66 F01F   BEQ $1F87
1F68 C901   CMP #$01
1F6A D006   BNE $1F72
1F6C AD0002 LDA $0200
1F6F 8DF902 STA $02F9
1F72 ADF902 LDA $02F9
1F75 E940   SBC #$40
1F77 B002   BCS $1F7B
1F79 C6FA   DEC $FA
1F7B 8DF902 STA $02F9
1F7E A8     TAY
1F7F 20F41F JSR $1FF4
1F82 68     PLA
1F83 A8     TAY
1F84 A900   LDA #$00
1F86 60     RTS
1F87 A900   LDA #$00
1F89 8DFA02 STA $02FA
1F8C A9D3   LDA #$D3
1F8E 85FA   STA $FA
1F90 AD0002 LDA $0200
1F93 8DF902 STA $02F9
1F96 D0E6   BNE $1F7E
1F98 A900   LDA #$00
1F9A 8DFA02 STA $02FA
1F9D 85F9   STA $F9
1F9F A9D3   LDA #$D3
1FA1 85FA   STA $FA
1FA3 A920   LDA #$20
1FA5 8DF802 STA $02F8
1FA8 A9CC   LDA #$CC
1FAA 8DF602 STA $02F6
1FAD 8DF902 STA $02F9
1FB0 A90D   LDA #$0D
1FB2 60     RTS
1FB3 98     TYA
1FB4 48     PHA
1FB5 20D61F JSR $1FD6
1FB8 ADF802 LDA $02F8
1FBB ACF902 LDY $02F9
1FBE 91F9   STA ($F9),Y
1FC0 8DF702 STA $02F7
1FC3 C8     INY
1FC4 EEF902 INC $02F9
1FC7 D002   BNE $1FCB
1FC9 E6FA   INC $FA
1FCB 20F41F JSR $1FF4
1FCE 68     PLA
1FCF A8     TAY
1FD0 ADF702 LDA $02F7
1FD3 4C99A3 JMP $A399
1FD6 48     PHA
1FD7 AD0002 LDA $0200
1FDA CDF602 CMP $02F6
1FDD 100D   BPL $1FEC
1FDF 38     SEC
1FE0 ADF902 LDA $02F9
1FE3 E940   SBC #$40
1FE5 B002   BCS $1FE9
1FE7 C6FA   DEC $FA
1FE9 8DF902 STA $02F9
1FEC AD0002 LDA $0200
1FEF 8DF602 STA $02F6
1FF2 68     PLA
1FF3 60     RTS
1FF4 B1F9   LDA ($F9),Y
1FF6 8DF802 STA $02F8
1FF9 A95F   LDA #$5F
1FFB 91F9   STA ($F9),Y
1FFD 60     RTS
1FFE A2A8   LDX #$A8
2000 202020 JSR $2020
2003 202020 JSR $2020
2006 202020 JSR $2020
2009 202020 JSR $2020
200C 202020 JSR $2020
200F 202020 JSR $2020
2012 202020 JSR $2020
2015 202020 JSR $2020
2018 202020 JSR $2020
201B 202020 JSR $2020
201E 202020 JSR $2020
```

their true values, all the variables etc. may be recalled as normal.

Below I have written a list of Zero Page addresses (which I believe to be correct) and which should help in understanding how the program works, and may prove useful to other UK101 users.

Addresses	Usage
01, 02	Contains address to which program jumps after RESET W.
OE	Contains length of input buffer (max. 71 bytes).
13–59	Input buffer, which is terminated by 00.
79, 7A	Text Start Pointer (TSP).
7B, 7C	Text End Pointer (TEP).
7D, 7E	Variable Store End Pointer (VEP).
7F, 80	Array Store End Pointer (AEP).
81–84	Pointers used for String Storage (SPs).
85, 86	Contains address of start of protected memory (or end of memory).
88	Flag which is set to FF, when in command mode.
8B, 8C	Program pointer which indicates current position in program.

```
10 DATA 44,3,2,16,25,169,253,141,0,223,169
20 DATA 16,44,0,223,240,10,173,0,240,74
30 DATA 144,238,173,1,240,96,238,3,2,32,0
40 DATA 253,72,138,72,44,44,2,16,70,165
50 DATA 127,205,38,2,240,48,48,21,238,38,2
60 DATA 238,36,2,208,3,238,37,2,238,34,2
70 DATA 208,3,238,35,2,208,228,206,38,2
80 DATA 206,36,2,201,255,208,3,206,37,2
90 DATA 206,34,2,201,255,208,3,206,35,2
100 DATA 208,203,162,4,189,39,2,149,128,189
110 DATA 33,2,149,122,202,208,243,169,0,141
120 DATA 44,2,104,170,104,201,13,240,1,96
130 DATA 72,138,72,186,189,8,1,201,169,240
140 DATA 6,165,19,201,58,48,4,104,170,104
150 DATA 96,201,49,48,248,169,255,141,44,2
160 DATA 162,10,181,122,157,33,2,202,208,248
170 DATA 165,127,133,123,165,128,133,124,208
180 DATA 223,169,45,141,24,2,169,2,141,44,2
190 DATA 141,25,2,96
500 FOR I = 557 TO 744
510 READ X
520 POKE I,X
530 NEXT
540 POKE11,219 : POKE12,2 : X=USR(X)
550 NEW
```

The BASIC portion of the program POKEs the machine code program (DATA statements) into the memory space between 0222H and 022E8H, and then executes the machine code, finally erases the BASIC.

VIDEO PINPOINT

Here is a short program for the 101 which allows character slot location on the display, in relation to its video RAM address. It was submitted by *T. Wilson* of Sittingbourne, Kent, and produces an arrow on the screen which can be moved around like so:

Key 1	UP
Key 2	DOWN
Key 3	LEFT
Key 4	RIGHT

The corresponding RAM address of the arrow's position appears at the top right of the screen. Very useful for setting up animated graphics! The program itself, if examined, gives a good insight into the POKEing of graphic characters around a memory mapped video screen. The Video RAM is located at 53248-54271 decimal on the UK101.

```
10 FORR=1TO16: ? :NEXT
15 POKE54221,32
20 S=53795:PL=16
25 GOSUB50
30 S=S+D:D=0
35 POKES,PL:IFS<>T THENPOKET,32
40 GOSUB100
45 GOTO25
50 REM * KEYBOARD *
55 POKE530,1:POKE57088,127
60 P=PEEK(57088):POKE530,0
65 T=S
70 IFP=127THENPL=16:D=-64
75 IFP=191THENPL=20:D=+64
80 IFP=223THENPL=22:D=-1
90 IFP=239THENPL=18:D=+1
93 IFS+D>54271 OR S+D<53248
   THEND=0
95 RETURN
100 REM* DISPLAY *
105 E$=STR$(S)+"    "
110 N=0
115L=LEN(E$)
120 FORR=53357TO53356+L
125 N=N+1:POKER, ASC(MID$(E$,N,1))
130 NEXT
140 RETURN
```

We added line 93 to confine the arrow to within the video RAM limits.

ALL'S WELL . . .

Sir,—Some time ago I wrote to you regarding a problem I had with my Compukit UK101. My machine's "Rubout" operated by leaving a trail of arrows, and I wanted to update it so that the cursor erased characters on screen. I had not had much luck so I wrote to you for advice.

I am pleased to say that due to the helpfulness of a young lady at Comp Components my machine is now updated. After a lot of ROMs being passed between me and Comp Components the correct combination was reached to make Rub-Out erase characters on screen. I in fact had to change BASICs 1 and 4, and Monitor ROMs.

I hope this may be of use to other readers trying to update their machines.

S. A. Smith
Kingston upon Thames.

RANDOMISING ROUTINE

The following information has been submitted by *David Swash* of Southampton.

After RESET, the RND(X) function always starts at the same point in the pseudo-random series; an undesirable characteristic, particularly in games programs.

The following is a simple randomising routine which may be included in any program, after the instructions (if any).

```
900  ?"TO START—PRESS 'C'"
910  POKE 530, 1
920  POKE 57088, 251
930  ZZ= RND(7)
940  IF PEEK (57088)= 191 THEN 960
950  GOTO 920
960  ?
970  POKE 530, 0
```

The distribution of numbers within the 1861 number series is not even, as the following table shows. This may be significant when making decisions based on the probability of a random number being within a certain range.

Range from	Nos. in range		
0	162		
0·1	188		
0·2	203	943	
0·3	202		
0·4	188		1861
0·5	180		
0·6	170		
0·7	189	918	
0·8	184		
0·9	195		

Initially, after RESET, the random number generator produces 2800 different numbers and then repeats the last 1861 of these. The distribution within the first 2800 is still uneven, however, being as follows:

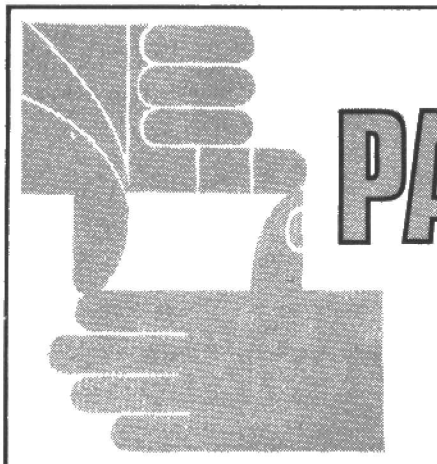
$$\underbrace{\underbrace{235\ 292\ 311\ 277\ 288}_{1403}\ \underbrace{289\ 254\ 283\ 281\ 290}_{1397}}_{2800}$$

Here are three miscellaneous tips thrown in for good measure:

(a) If RETURN is pressed in reply to an INPUT statement (i.e. no data) then, as described in the manual, the program is aborted. However, it can be restarted by using CONT, which results in a repeat of the INPUT request.

(b) Quotes can be omitted from character strings in DATA statements (but not in assignments).

(c) There is an additional BASIC error code: B$\surd$—Attempt to reference an array beyond its dimensioned bounds.



PATENTS REVIEW...

Copies of Patents can be obtained from:
the Patent Office Sales, St. Mary Cray, Orpington, Kent. Price 95p each.

REMOTE CONTROL

Airfix Products have a new British patent application (2 026 747), filed in July 1978 under the new laws, which sets out to improve the remote control of DC motors, especially those used in model railways. In the simplest model railway control systems only a single locomotive can be run independently on a particular length of track at any one time. Digital control systems have been proposed which give independent control of more than one train on the same length of track. But according to Airfix there have been problems over interaction between different locomotives, largely due to the electrical interference generated by the brushes and commutators used in DC motors. Airfix point out that if high frequency control waveform bursts are superimposed on a 50Hz wave, the motor will respond more reliably. The lengthy patent explains practical ways of putting this theory into practice.

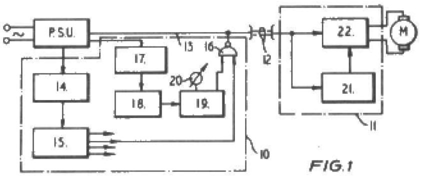


FIG.1

Figure 1 shows a system which permits control of both the direction of rotatation and power (hence speed) of a DC motor. Power Supply Unit provides 20 volt AC on line 13 and also DC to master oscillator 14. This oscillator feeds a fixed frequency output signal to digital divider 15 which provides different frequency outputs for different control channels. Only one of four outputs is shown, selected and fed to NAND gate 16 for one of four channels. PSU also supplies low voltage AC to waveform shaper 17 which outputs a 50Hz square wave operating between logic levels zero and one. Phase switch 18 allows either logic zero or logic one to be switched onto positive half cycles of the waveform on line 13. Monostable 19, with time constant and pulse width variable at 20, outputs also to NAND gate 16.

At the receiver, a detector 21 is tuned to the frequency of the selected channel of divider 15 and so provides an output to solid state switch 22 whenever it detects its preset frequency, i.e. whenever a signal is routed onto line 13 through gate 16. Switch 22 then feeds power to motor M, which is driven by a positive or negative half cycle of the waveform supplied along line 13 from the PSU.

Monostable 20 has a maximum pulse width of one half cycle of the 50Hz waveform on line 13 and is variable within this limit by control 20. Because the selected frequency is present only during the positive or negative half cycle (depending on the setting of phase switch 18) current is supplied to the motor in one sense only and the power produced depends on the duration of the selected frequency on each half cycle. Extensive details are given in the patent of a full 16 channel control system operating on this basic principle.

SHORT PROTECTION

The Rank Organisation, naming Winfried Kummel as inventor, has filed a new British patent application (2 026 274) for a simple but interesting approach to the protection of amplifiers against output short circuits, for instance in their loudspeaker load. High powered amplifiers are now common, with power ratings of 500 watts and even above available. Any short circuit of the output either causes the transistors to self destruct or oscillate in the HF region and damage the loudspeaker tweeters. Protection circuitry suitable for low powered amplifiers often cannot act fast enough for such high power ratings.

The new invention is based on the well-known facts that (a) an electromagnetic field is formed around any conductor which carries an electric current and (b) if a second conductor is laid alongside the first, a proportional current is induced in it. Rank suggest that this induction can be used to operate a safety circuit. Although the system is primarily intended to protect audio amplifiers against loudspeaker short circuits, the theory is clearly applicable in a wide range of generator-load situations. But whether the idea will be adjudged new and patentable by the British Patent Office is an open question.

In its simplest form the protection circuit (Fig. 1) relies on a passive conductor 13 closely parallel to a conductor 11 which carries power from amplifier 10 to loudspeaker load 12. When sensor 14 detects current above a threshold value in the line 13, a risk situation is signalled. The conductors 11 and 13 can be either conventional flex or the conductor and braiding of a screened cable.

Fig 1

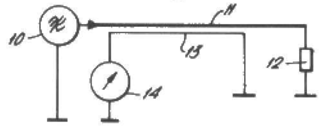


Fig 2

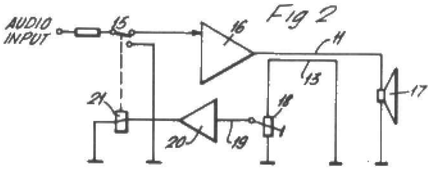


Figure 2 shows a simple device 18 for setting the threshold and an op amp 20 for operating relay 21 when the current in line 13 passes the pre-selected value. As relay 21 changes state its contacts 15 disconnect, and so protect amplifier 16. Alternatively (Figure 3) the op amp can control Schmitt trigger 22 which cuts off the mains supply to the amplifier 16.

Fig.3

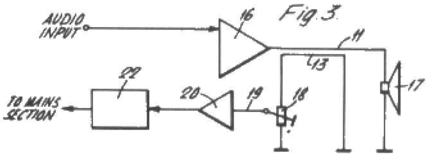
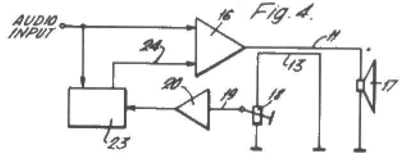


Fig.4



An extension of the idea (Figure 4) feeds the op amp signal to a comparator 23 which also receives a part of the input signal being fed to amplifier 16. The comparator produces a correction signal on line 24 which varies the output of the amplifier 16 either to protect the loudspeaker 17 or, in feedback fashion, to minimise distortion.

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